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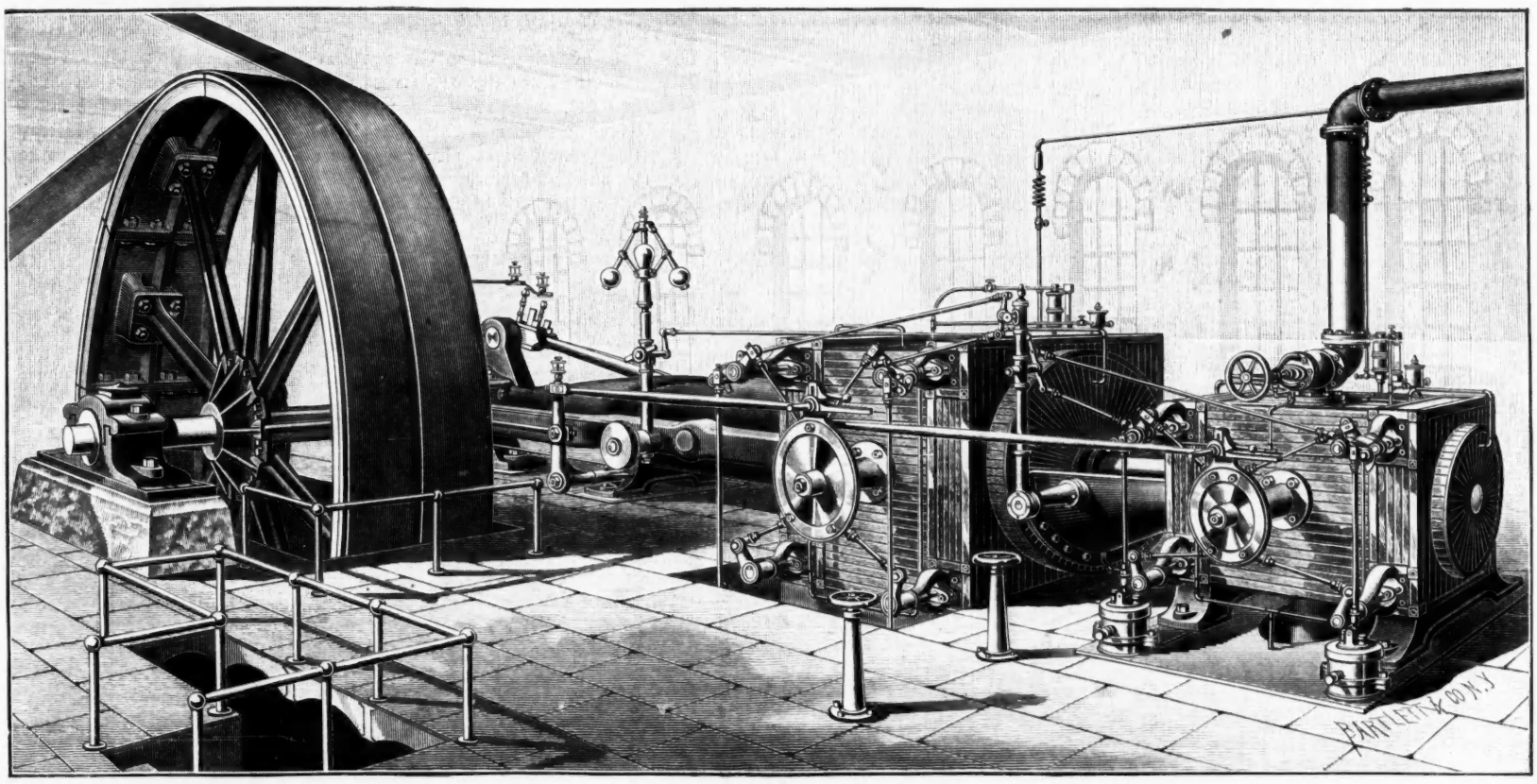
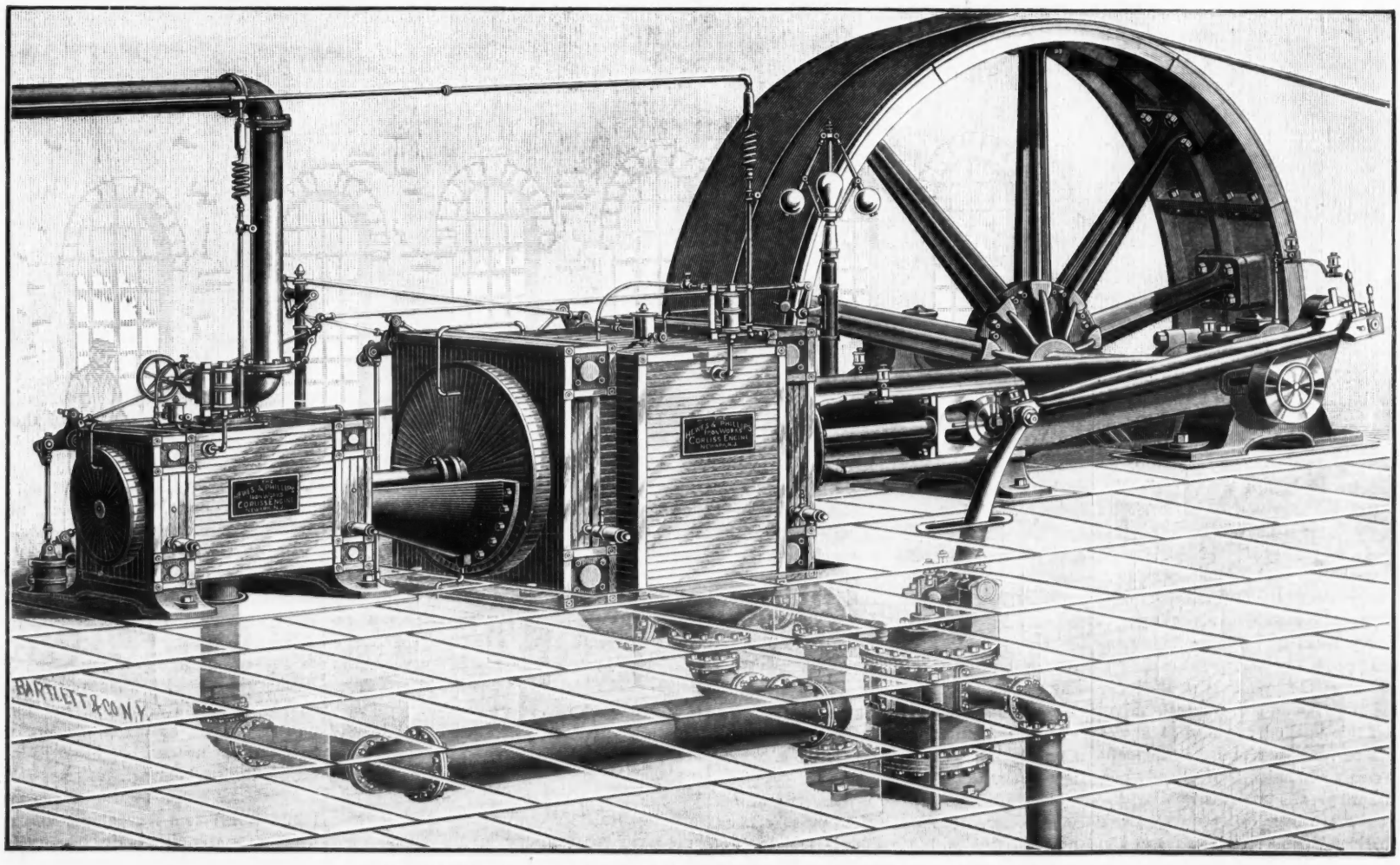




TANDEM COMPOUND CONDENSING ENGINE, BY HEWES AND PHILLIPS' IRON WORKS.

Tandem Compound Condensing Engine—Manning Vertical Tubular Boilers.

The above illustrations represent a compound tandem condensing engine, recently built at Hewes & Phillips' Iron Works, Newark, N. J. This engine was built for the East River Electric Light Company, East Twenty-fourth street, New York City. The great aim in the design of this engine is to secure a maximum economy of fuel; also a comparatively uniform speed, not only throughout one revolution of the crank, but through every period of time; great care has also been taken to isolate the cold exhaust from the hot "live steam." The steam cylinders, as well as the heads, are thoroughly steam jacketed; and the water due to condensation in the jackets is returned, by means of a suitable jacket pump, into the boilers.

This jacket pump, the air pump, condenser, and a system of piping, are all placed underneath the floor, as shown in the illustration. The steam from the high pressure cylinder is conducted through a portion of this system of piping, directly into the low pressure cylinder; no receiver between the two cylinders is used. From the low pressure cylinder the steam is conducted into the upright jet condenser, shown at the left-hand side of the air pump, and from thence the air pump takes the water, and allows it to flow into the sewer. In this particular engine salt water is used for condensation, and therefore none of the water due to the condensation of steam from the cylinders is returned into the boilers.

The air pump is worked from a lever and return rod from the crank; part of this lever is shown above the floor. The small jacket pump is placed on top of the air pump, or, we should say, on top of the hot well, and is worked from the same lever. The cylinders are 22 and 44 inches diameter, by 48 inches stroke; the low pressure cylinder is made to stand 50 pounds' initial pressure. The throttle valve on high pressure cylinder is 8 inches diameter. The bed and pillow block are tied together with 1¼-inch iron bands, shrunk on. The pillow block bearing 13½ inches diameter, and 26 inches long; shaft, 15 inches diameter; crank-pin, 8 inches diameter and 8 inches long; air pump, single acting, 32 inches bore by 12 inches stroke; the flywheel, 24 feet diameter and 60 inches face; weight, 58,000 pounds. The hub is made in two pieces, pressed onto, keyed and bolted fast to the shaft; the rim is made of ten segments.

The valve gear is of the Corliss type. The clearance spaces between the valves and cylinder are very short and direct; the valves ha e long supports, or bearings, at each end. The steam enters the cylinders at the inner edge of the port towards the throttle valve. In adopting this method, too abrupt angles in the steam current are avoided; the result is that the steam admission is practically perfect. No springs are used for holding the steam or exhaust valves to their seats; this result is obtained by taking advantage of the steam pressure and the weight of the valves. These valves are, like all Corliss valves which are properly designed and fitted up, practically balanced, so that they can be operated by hand with the throttle open. In all engines made by this firm, the valves can be removed from the cylinder for examination, and replaced without the removal of any part of the releasing gear. All the mechanism of the releasing gear moves about a common center, which is the center of the valve stem; this makes the leverage of detaching or releasing a constant quantity. Great care has also been taken to reduce as much as possible the friction of the releasing gear; in fact, the whole aim in the design of this gear is to reduce the work of the governor to a minimum.

The design of the governor and its connection is well adapted for a close regulation. It is claimed that this governor is exceedingly sensitive to changes of speed, and since it has comparatively very little work to do, will adjust itself very quickly to the smallest change in the load or steam pressure. This governor controls the action of the steam valves in both cylinders; yet the arrangement of its connection is such as to permit the governor to control the action of the high pressure cylinder only, and cause the valves in the low pressure cylinder to cut off at certain fixed points. In some of the engines built by this firm the action of the steam valves in the low pressure cylinder is controlled by the pressure in the receiver. This governor has no dash-pot, as the mechanical devices employed in the valve motion perform their work in a quiet manner, and do not transmit a shock or disturbance to the governor.

The steam valves are closed by a vacuum dash-pot of improved design. It works very quietly and gives the steam valves a rapid movement in closing; the valves cross the port edges at a maximum velocity. Several very simple attachments are made to this dash-pot, so that its action can be easily and thoroughly controlled. It is a difficult mat ter to describe this dash-pot without illustrations, but we trust that in the near future we may be able to give a description and illustration of the same.

This firm builds, besides the tandem compound type of engine, another one, which they name the "Cross-compound."

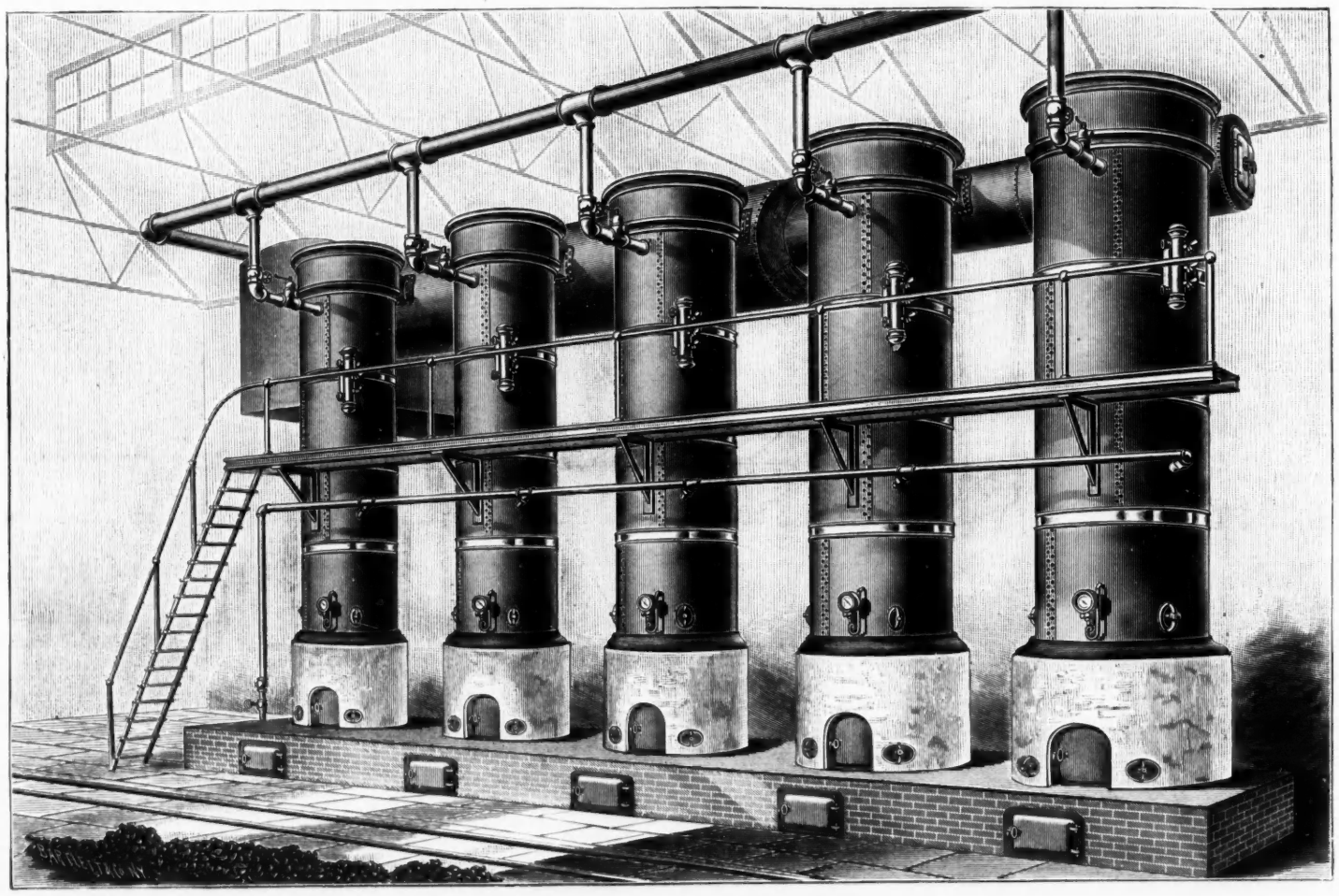
The tandem compound is more economical in space, and the connecting pipe between the two cylinders is more direct, with less exposure of surface to external cold. The cross-compound, while occupying more space, is more accessible for adjustment to the piston and piston rods, and will produce more uniform rotary motion by reason of the cranks being set at 90 degrees with each other.

On this page we also give an engraving of of the boilers recommended especially for compound engines. They are known as the Manning Vertical Tubular Boiler, their especial advantage for use in connection with compound engines being the fact that they are capable of carrying the high pressures necessary to secure economical results. They are designed to carry 150 lbs. pressure if required, and are tested to 200 lbs. They require comparatively little floor space, the five boilers shown being rated at 900 h. p., and occupying a floor space of 8 x 40 feet only.

They are internally fired, the fire-box being 72 inches in diameter, 45 inches high, and having 28.25 square feet of grate area. There are 180 2¼-inch tubes, 15 feet long, the total heating surface in each boiler being 1,854 square feet. The normal water line is 11 feet from the lower head, giving 4 feet of the flues exposed to steam at the upper end for superheating, tests of temperature having shown that at 70 lbs. pressure the steam was superheated about 24°, though we have no data in a case where a higher pressure was carried. By this arrangement also it is claimed that the excess of temperature of escaping gases over the temperature of the steam is reduced, and the greatest economy secured. The shell and fire-box sheets are $\frac{7}{16}$ inch thick, and the heads ½ inch.

At the bottom of the water leg, and passing entirely round it, is a chain which lies loosely on the bottom, and by removing the hand-hole plates, seen each side of the fire-doors, this chain may be pulled around one way and the other, to loosen any scale or deposit which may take place there.

The boilers are covered on the outside with magnesia or asbestos cement, to prevent radiation, over all being a covering of Russia iron with brass bands, making a very neat finish. The total height of the boilers from the floor is 23½ feet.



BOILERS BY HEWES & PHILLIPS' IRON WORKS.

John Black, formerly master mechanic of the Cincinnati, Hamilton & Dayton Railway, has been appointed general master mechanic of the Chicago & Atlantic, with headquarters at Huntington, Ind.

Freight cars made of iron and steel instead of wood—an American invention—have been adopted upon the Furness Railway, England. Two "Goodfellow and Cushman" cars, constructed in Huntington, Pa., were shipped in sections to England, put together there, and thoroughly tested to the entire satisfaction of the railway officials of several roads, who were present. There seems a likelihood that these cars will be adopted on a number of the roads of the United Kingdom.

We learn by circular from Secretary Forney that the next meeting of the Master Car Builders' Association will be held at Saratoga Springs, beginning Tuesday, June 25, at 10 o'clock, A. M. Headquarters will be at Congress Hall.

New Gear Tables.

Professor J. F. Klein, Professor of Mechanical Engineering at Lehigh University, has performed a valuable service to mechanics, engineers, and in fact all who have to do with the formation of gear teeth, by the compilation of his recently published *Gear Tables for Laying out Accurate Tooth Profiles.* Unlike the charts, etc., which have preceded it, it does not confine the user to one certain form of teeth, but enables him to readily and easily lay off all the forms in common use, as well as some which rarely occur in practice. The system followed, while it has evidently involved a great deal of conscientious and painstaking labor on the part of the author, has rendered it very easy for the busy mechanic or engineer to lay off any desired form of gear tooth with great accuracy, without preliminary drawing-room work, and with the simplest of calculations, involving only short division and multiplication. The method consists in giving by tables, the distances of points of the tooth profile from each of two perpendicular reference lines; this involves only the use of the square and ability to lay off distances accurately. Each of these two sets of distances is expressed in simple decimal fractions of the pitch or diameter, and for ease in tabulation, computation and laying out, one of these sets is arranged in groups of equi-different values.

Special care has been taken to make the tables convenient for pattern workers and machinists by arranging them principally for the current, common systems of tooth profiles, by making the points along one reference line equidistant, so that they can be easily stepped off by the dividers, and by so grouping them that the designer can easily choose few or many points, as his degree of accuracy may require.

The tables will also meet the needs of draftsmen and engineers who desire to obtain special forms differing from the common, interchangeable types that are current. For these Table III. gives the co ordinates for rack teeth when *any* size of describing circle is used, while Tables V. and VII. give special involutes for which the line of tooth thrust lies somewhere between the practical limits of 70° and 80°; and finally Tables VIII. and IX. give the co-ordinates of the profile for any ratio of describing circle to pitch circle that may be desired. To further guide the designer in choosing the proper ratio, the thrust angle made by the tip of tooth is indicated by heavy lines between the columns.

The special needs of students and instructors in technical colleges have also been considered.

There are in all nine tables, the uses of which are made clear by examples worked out in detail and by suitably drawn figures.

The tables are printed on both sides of one large card $17'' \times 20''$, so as to get them into as compact form as possible for use in the shop, drafting-room or college. The card is of the best bristol board, and may be stretched in an open frame, with or without double glasses.

It is sold by Edwin G. Klosè, Bethlehem, Pa.

There are several surface roads in Birmingham, England, upon which steam engines are used as motors, and there is so much objection made to their use that there is talk of refusing to renew the licenses. They call the steam motors "nuisances."

Modern Locomotive Construction.

BY J. G. A. MEYER.

EIGHTY-FOURTH PAPER.

In designing a main crank-pin, care must be taken not to make its journals too long, because an increase of length will weaken the pin; the diameters of the journals should not be larger than necessary, because enlarging the diameters will occasion a loss of work due to friction. Consequently, there should be a ratio between the diameter and the length of a locomotive crank-pin journal; and this ratio can best be established by the proportions of crank-pins now in actual and successful service.

In all locomotives which have more than one pair of drivers, the main crank-pins have two journals, as shown in Fig. 471. One of these journals is the main rod journal; the other is the side rod journal.

In wide gauge (4 feet 8½ inches) eight-wheeled passenger engines, the main rod is nearly always placed next to the wheels; in narrow gauge eight-wheeled passenger engines we are frequently obliged to place the side rod next to the wheel. If Fig. 471 represents a crank-pin designed for an eight-wheeled passenger engine (4 feet 8½ inches gauge), then the journal *B* will represent the main rod journal; and the journal *C* will represent the side rod journal. The portion *A* of the pin which is pressed into the wheel, is called the wheel fit.

Let Fig. 471 represent a main crank-pin for an eight-wheeled passenger engine: it is required to find the diameter *D* and the length *L* of the main rod journal *B*; it is also required to find the diameter *d* and the length *l* of the side rod journal *C*.

Let us commence by finding the dimensions of the main rod journal *B*. Our first step will be to establish a ratio between its diameter *D* and its length *L*. It is not often that we find in eight-wheeled passenger engines a crank-pin in which the length of the main journal exceeds the diameter of the same journal; but there are a number of eight-wheeled passenger engines, in which the length and diameter of the main rod journal are equal to each other; and lastly, we believe it is safe to say that, in the majority of engines, the diameter of the main journal is greater than the length of the journal. In the latter cases the ratio between the diameters and lengths, as made by different builders, varies somewhat; but good practice seems to indicate that the diameter of the main rod journal should be about 1½ times larger than its length. Occasionally crank-pins need to be trued up a little, for which a small allowance should be made. Hence, in determining the dimensions of the main rod journal, we shall first find its diameter and length, whose ratio is as 1½ to 1, and then add, to allow for wear, about $\frac{1}{16}$ to ⅛ of an inch to the diameter thus found. We say *about* $\frac{1}{16}$ up to ⅛ of an inch, because the diameter determined by calculation will in many cases contain a fraction of an inch, and when this fraction does not contain even ⅛th inches we shall then add a little less, or in some cases a trifle more than ⅛ of an inch, so as to make the fraction divisible by ⅛ of an inch; indeed, many locomotive builders do not adopt a diameter which cannot be divided by ¼ of an inch. If the diameter obtained by calculation contains even ⅛ inches, we simply add ⅛ of an inch for wear. When the length of the journal, as found by calculation, contains fractions which cannot be divided by ⅛ of an inch, we simply take the nearest fraction divisible by ⅛ of an inch to that found; hence, in some cases the lengths adopted may be a little less, and in others a little greater than that found by calculation.

For the sake of simplicity, we shall assume that the whole steam pressure on the piston is exerted to turn the wheels, allowing nothing for the friction of piston, etc.; we shall also neglect the pressure due to the obliquity of the main rod.

Now, since the pressure per square inch of projected area of steel crank-pin journals is to be 1,600 pounds, we can readily find, under the foregoing conditions, this area when the steam pressure on the piston is known, thus:

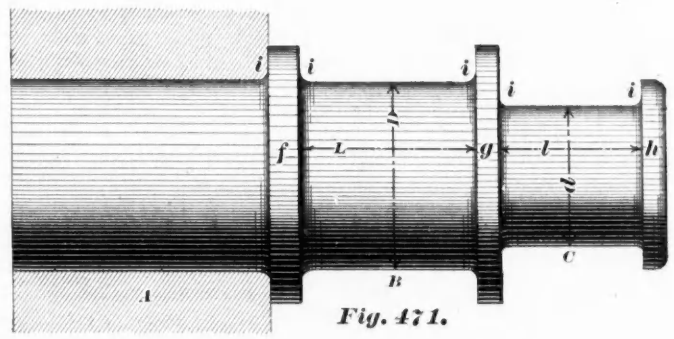


Fig. 471.

Rule 71. For crank-pins made of steel; divide the total maximum steam pressure on the piston by 1,600; the quotient will be the number of square inches in the projected area of the main rod journal for eight-wheeled passenger engines.

Now, since the diameter of the journal is to be 1½ times its length, we have the following rule:

Rule 72. Multiply the projected area (as found by Rule 71) by 8, and divide the product by 9; extract the square root from the quotient; this square root will be the length of the journal. Multiply this length by 1.125, and add for wear so as to make the diameter divisible by ⅛ of an inch; the sum will be the required diameter.

Example 103. Find the dimensions for the main rod crank-pin journal for a passenger engine having cylinders 18 inches diameter; maximum steam pressure per square inch of piston, 130 pounds.

The area of an 18-inch piston is 254.47 square inches; hence, the total maximum steam pressure on the piston will be

$$254.47 \times 130 = 33{,}081.10 \text{ pounds.}$$

According to Rule 71, the number of square inches in the projected area of the main rod journal will be

$$\frac{33{,}081.10}{1{,}600} = 20.67 \text{ square inches.}$$

According to Rule 72, we find the length to be

$$\sqrt{\frac{8 \times 20.67}{9}} = 4.28 \text{ inches.}$$

And the diameter we find to be

$$4.28 \times 1.125 = 4.815 \text{ inches;}$$

adding to this diameter .06 (which in this case is a little less than $\frac{1}{16}$ of an inch) we obtain 4⅞ inches. Hence, the diameter of this journal should be 4⅞ inches, and its length, 4¼ inches.

Side rod journals on the main crank-pins for eight-wheeled passenger engines.

To determine the dimensions of the side rod journal we proceed in manner similar to that adopted for finding the dimensions of the main journal. Our first step will be to find the projected area. In good practice we find that, in eight-wheeled passenger engines, the projected area of the side rod journal is equal to about 65 to 75 per cent. of the projected area of the main rod journal; we believe that about 70 per cent. is a good proportion. Hence, when we know the projected area of the main rod journal, that of the side rod journal may be found by making it equal to about 70 per cent. of the former. But this result can be obtained in a more direct way by the following rule, which will give results agreeing well with the average good practice.

Rule 73. For steel crank-pins; divide the total maximum pressure on the piston by 2,400; the quotient will be the number of square inches in the projected area of a side rod journal for eight-wheeled passenger engines.

In many locomotives we find the length of the side rod journal to be equal to its diameter; on the other hand, we find as many, if not a greater number of engines, in which the diameter of the side rod journal is greater than the length of the same. In the latter class, the ratio between the diameters and lengths, as made by different makers, varies somewhat, but good practice seems to indicate that the ratio between the diameter and length should be like that of the main rod journal, namely, the diameter should be 1½ times larger than the length; and these proportions we shall adopt.

To the diameters thus found we shall also add $\frac{1}{16}$ to ⅛ of an inch, so as to avoid fractions which cannot be divided by ⅛ of an inch. As for the length of the side rod journals, we shall simply adopt such as can be divided by ⅛ inch, and which will be the nearest to the fraction found by calculation, and therefore may in some cases be less and in others greater than that for which the rule calls.

Rule 74. To find the length and diameter of a steel side rod journal for eight-wheeled passenger engine.

Multiply the projected area of the side rod journal (as found by Rule 73) by 8, and divide the product by 9; extract the square from the quotient; this square root will be the required length. Multiply the length by 1.125, add to the product from $\frac{1}{16}$ to ⅛ of an inch, so as to obtain a numerical value divisible by ⅛ of an inch; the sum will be the required diameter.

Example 104. Find the dimensions for the side rod journal for a passenger engine having cylinders 18 inches diameter; maximum steam pressure per square inch of piston, 130 pounds.

We have already found, in Example 103, that the total maximum steam pressure on the piston is 33,081.10 pounds; hence, according to Rule 73, we have

$$\frac{33{,}081.10}{2{,}400} = 13.78 \text{ square inches, which is the}$$

projected area of the side rod journal.

According to Rule 74, the length should be

$$\sqrt{\frac{8 \times 13.78}{9}} = 3.49 \text{ inches.}$$

For the diameter we have, $3.49 \times 1.125 = 3.926$ inches; to this add .199 inch; the sum will be 4.125, which is the required diameter; hence, the side rod journal should be 4⅛ inches diameter, and 3½ inches long.

In this manner the diameters and lengths of steel crank-pins given in the following tables have been obtained.

TABLE A.

Dimensions of Steel Crank-Pin Journals for Eight-wheeled Passenger Engines (four wheels connected). Maximum Steam Pressure on the Piston, 120 pounds per square inch. Letters at the head of columns refer to Fig. 471.

Diameter of Cylinders.	Main Rod Journals. Diameter *D*	Length *L*	Side Rod Journals. Diameter *d*	Length *l*
9	2⅜	2	2	1⅝
10	2⅝	2¼	2⅛	1⅞
11	2⅞	2½	2⅜	2
12	3⅛	2¾	2⅝	2¼
13	3⅜	3	2⅞	2½
14	3¾	3¼	3⅛	2⅝
15	4	3½	3¼	2⅞
16	4¼	3⅝	3½	3
17	4½	3⅞	3⅝	3⅛
18	4¾	4⅛	3⅞	3⅜
19	5	4⅜	4⅛	3½
20	5¼	4½	4⅜	3¾

TABLE B.

Dimensions of Steel Crank-Pin Journals for Eight-wheeled Passenger Engines (four wheels connected). Maximum Steam Pressure on the Piston, 130 pounds per square inch. Letters at the head of columns refer to Fig. 471.

Diameter of Cylinders.	Main Rod Journals. Diameter *D*	Length *L*	Side Rod Journals. Diameter *d*	Length *l*
9	2⅛	2⅛	2⅛	1¾
10	2¾	2⅜	2¼	2
11	3⅛	2⅝	2½	2⅛
12	3⅜	2⅞	2¾	2⅜
13	3⅝	3⅛	2⅞	2½
14	3⅞	3⅜	3⅛	2¾
15	4⅛	3½	3⅜	3
16	4⅜	3¾	3⅝	3⅛
17	4⅝	4	3⅞	3⅜
18	4⅞	4¼	4⅛	3½
19	5⅛	4½	4¼	3⅝
20	5½	4¾	4½	3⅞

TABLE C.

Dimensions of Steel Crank-Pin Journals for Eight-wheeled Passenger Engines (four wheels connected). Maximum Steam Pressure on the Piston, 140 pounds per square inch. Letters at the head of columns refer to Fig. 471.

Diameter of Cylinders.	Main Rod Journals. Diameter *D*	Length *L*	Side Rod Journals. Diameter *d*	Length *l*
9	2⅝	2¼	2⅛	1⅞
10	2⅞	2½	2⅜	2
11	3⅛	2¾	2⅝	2¼
12	3½	3	2⅞	2½
13	3¾	3¼	3⅛	2⅝
14	4	3½	3¼	2⅞
15	4¼	3¾	3½	3
16	4⅝	4	3¾	3¼
17	4⅞	4¼	4	3½
18	5⅛	4½	4¼	3⅝
19	5⅜	4⅝	4½	3⅞
20	5⅝	4⅞	4⅝	4

TABLE D.

Dimensions of Steel Crank-Pin Journals for Eight-wheeled Passenger Engines (four wheels connected). Maximum Steam Pressure on the Piston, 150 pounds per square inch. Letters at the head of columns refer to Fig. 471.

Diameter of Cylinders.	Main Rod Journals. Diameter *D*	Length *L*	Side Rod Journals. Diameter *d*	Length *l*
9	2¾	2⅜	2¼	1⅞
10	3	2⅝	2½	2⅛
11	3¼	2⅞	2¾	2¼
12	3⅝	3⅛	3	2½
13	3⅞	3⅜	3⅛	2¾
14	4⅛	3⅝	3⅜	3
15	4½	3⅞	3⅝	3⅛
16	4¾	4⅛	3⅞	3⅜
17	5	4⅜	4⅛	3½
18	5¼	4⅝	4⅜	3¾
19	5⅝	4⅞	4⅝	4
20	5⅞	5⅛	4¾	4⅛

TABLE E.

Dimensions of Steel Crank-Pin Journals for Eight-wheeled Passenger Engines (four wheels connected). Maximum Steam Pressure on the Piston, 160 pounds per square inch. Letters at the head of columns refer to Fig. 471.

Diameter of Cylinders.	Main Rod Journals. Diameter *D*	Length *L*	Side Rod Journals. Diameter *d*	Length *l*
9	2¾	2⅝	2¼	2
10	3⅛	2⅞	2½	2⅛
11	3⅜	2⅞	2¾	2⅜
12	3⅝	3⅛	3	2⅝
13	4	3½	3¼	2⅞
14	4¼	3¾	3½	3
15	4⅝	4	3¾	3¼
16	4⅞	4¼	4	3½
17	5⅛	4½	4¼	3⅝
18	5½	4¾	4½	3⅞
19	5¾	5	4¾	4⅛
20	6⅛	5¼	5	4⅜

The dimensions for the side rod journals on the rear crank-pins are the same as those given in the foregoing tables for the side rod journals on the main crank-pin.

Bits of Experience.

BY PEDRO.

MOUNTING DRAWING PAPER.

It may seem a simple thing to write about such "small matters" as mounting drawing paper, but the writer's experience with and among draftsmen has conclusively shown that there are a great many who need instruction on this and other "unimportant preliminaries." I have seen men, at Mugwump's shop, who considered themselves first-class draftsmen, who actually spent more than a half day in mounting a sheet of paper on a drawing board, and then it proved to be a first-class botch after the paper was dry. I have also seen a boy about twelve years of age—not a draftsman—mount all the paper for two dozen draftsmen, and he did it well, too. These facts go to show that there is either not enough or not the right kind of instruction given by teachers in regard to mounting paper, or that there is a widespread inability to apply the instructions in practice. The natural laws to be observed are very simple, but must be respected if good results are desired. Of these laws there are mainly two: first, *paper will expand if moistened, and contract again as it dries.* Second, *pastes, glues, etc., will not resist much tension as long as they are not "set," or dry.*

Hark! there I hear one thousand and one voices, saying, "Pshaw, I knew that before you was born; give us something harder." It is none the less true that I have seen the first law disregarded in Mugwump's shop, where Stork was head draftsman, about as often as paper was mounted by his directions; and I have seen, as the result, about as many "botches," which any first-class draftsman would be ashamed to have anybody see. Mugwump's shop is not one of the lowest grade, either, in workmanship, so that we would expect better work there. In fact, he *claims* to have the best shop in his section of the country, and he even aspires to a foreign reputation. It may also be stated that, taking observations among the draftsmen in Mugwump's shop gives any one the advantage of a large number of that fraternity, as there is a constant stream of them flowing in at the front office door, through the shop and out at the side door. Very few tarry long to combat the daily insults which invest that locality.

It was with a great deal of amusement that any one might have witnessed the process of mounting a tracing, by Stork, upon a cardboard, to be used in the shop as a working drawing—an old fogy process, of course, in these days of blue printing. Taking about a half pint of mucilage, Stork would pour it in a heap in the center of a two by three feet cardboard. He would then take the tracing and place it on the cardboard in its desired position over the blotch of mucilage. Then, taking a burnisher, made of a piece of board with the edges rounded, he would press the dry tracing upon the mucilage at the center, rubbing it down from the center toward the edges of the board and let the excessive mucilage run off the edges upon some waste paper, previously placed under the board. This rubbing down process was the scientific part of the job. It had to be done quickly, "to make the tracing lie smooth." The gyrations of the body and the wafting in the breeze of a long tail coat during this process, can be imagined better than described. No sooner had he rubbed the tracing down "smooth," than the real fun for the operator began. It was time, at this stage of the process, for the tracing to expand. It began to "pucker." As the wrinkles appeared here and there, they were treated frantically with the burnisher, some re-appearing while others were operated upon. Now and then a dive into the pocket brought forth a concealed weapon, and the more obstinate wrinkles came to grief by being ripped open and then subdued with the burnisher. Of course, this part of the programme had to be continued until the tracing ceased to expand. By the energetic and scientific gyrations of the body, the burnisher and the knife, a passable job was sometimes done; but oftener it would have served admirably as an imitation of the time-honored "washboard." Sometimes these jobs were turned over, with instructions in the "tricks of the trade," to an apprentice, and these were usually ingenious enough to utilize the "waste mucilage," which flowed from the edges of the cardboard, to increase the adhesive qualities and the co-efficient of friction of the surrounding objects. This was found especially effective on desks,

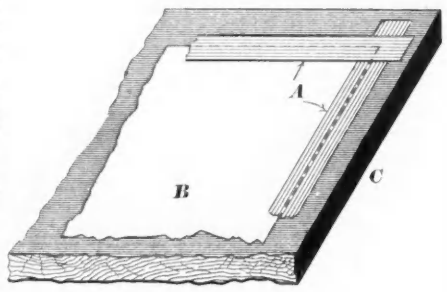


Fig. 1
MOUNTING DRAWING PAPER.

benches, chairs, etc., to prevent accidents by slipping. In this way this man and others in Mugwump's shop violated the first law, stated above, for years, and did not learn by experience how to turn it to his advantage; and yet, if any one had intimated that he was ignorant of this simple law, or offered some suggestions, he would have been offended, and wondered how any one *dared* to attempt to instruct him. I think he knows no better to this day.

Let us mount a piece of paper on the drawing board to follow the different steps in their order. Having secured the piece of paper and a good, clean sponge, we moisten the paper sufficiently to expand it a little more than it will naturally expand by the moisture of the atmosphere in the dampest days. This means that the paper is not to be slushed with water indiscriminately, but the kind of paper used must, to some extent, determine the amount of water to be applied. It is not necessary nor desirable to stretch paper any tighter than is required to prevent it from wrinkling in most weather. Paper is liable to be injured when stretched too tight. I have seen paper slushed so excessively that it was ruined by being torn asunder in the act of drying. Some paper requires less moisture than others. A good practice with some thin papers is, to not moisten it at all directly, but to moisten the board; then squeeze the sponge and wipe it as dry as possible, after which lay the dry paper upon the board, allowing it to absorb some of the moisture before fastening it. This method works well with such papers as parchment, bond, tracing, etc.

Having expanded the paper sufficiently, paste it on the board around the edges. Do not paste the paper first and moisten it afterwards, as I have seen done by a draftsman.

In regard to *pastes*, the following suggestions may be made to good advantage. There has been a great deal of trouble caused by using mucilage which was too thin. If mucilage is used, it is best to prepare it yourself by dissolving gum arabic in water until it forms quite a thick paste. There is a liquid glue in the market, which has been introduced within a few years. This is so far superior to mucilage, and is such an excellent article, that I use nothing else as long as it can be obtained. The most convenient, expeditious and satisfactory method is to prepare one side of a sheet of paper with a thick coat of the liquid glue, and, when dry, cut the sheet into strips about one-half of an inch wide. A quantity of these can be kept on hand for use when wanted. By drawing a wet sponge over the prepared side of the strip, it can be applied, like a postage stamp, to the edge of the drawing paper and the board, as shown in Fig. 1, *C* representing one corner of the drawing board, *B* the paper, and *A* the pasting strips. By this plan paper can be mounted in less time, and the paste will dry sooner than by the old way. It is best to use thin and strong paper for the strips. Scraps and waste tracing cloth can be used to good advantage in this way.

After the paper is glued all around the edges, wet it with a sponge, so as to relieve all the tension on the paper; but in doing so, be careful *not* to wet the edges where the glue is. It is here where the second law, stated above, is so often violated and results in failure. Generally, after the paper is pasted around the edges, the board is laid away to dry, and if, in drying, the edges break loose, the mucilage or something else must take the blame. Perhaps it is sometimes fortunate for the operator that these dumb *somethings* are very considerate, and will take a great deal of abuse. There will be little or no trouble, if it will only be remembered that the paper usually dries faster than the mucilage around the edges, and, as the paper begins to "draw up," the mucilage, which is yet moist, is not able to resist the tension, and it gives way. Keep the paper wet inside of the glued border, to relieve the tension, until the glue is dry enough to resist it, and you will see how easy it is to "make the paper stick." Of course it is essential to have a clean board. Pastes will not adhere to a greasy surface.

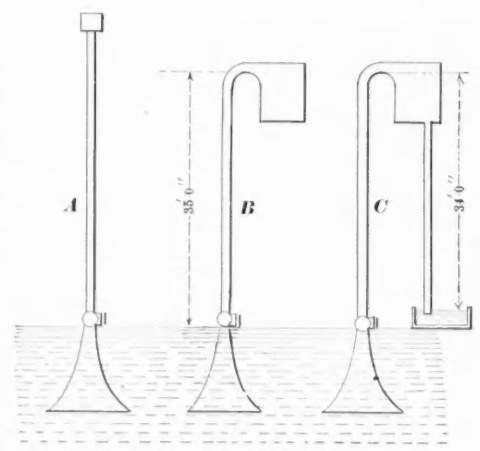


Fig. 4

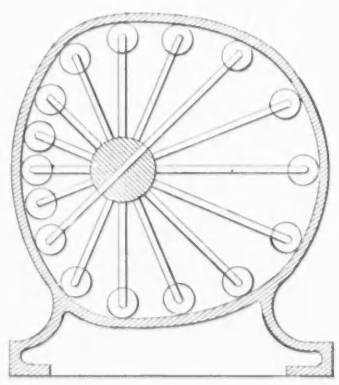


Fig. 1

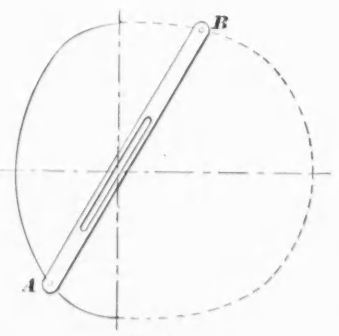


Fig. 2

Fig. 3

PROBLEMS INVOLVING PERPETUAL MOTION.

It may be stated, in this connection, that the surface of drawing boards should be slightly convex; then, if a few pin-holes are pricked through the paper around the edges, to let the air escape from underneath, it will lie close to the board all over the surface. Every draftsman knows what an annoyance it is to have the paper cushioned, or bridged, across a concave board.

Lead weighs 709 lbs. per cu. foot.

Problems Involving Perpetual Motion.

BY C. L. REDFIELD.

I do not remember having seen any articles in the AMERICAN MACHINIST, describing perpetual motion devices. I can think of three reasons for this, any one of which may be sufficient to account for the circumstance. First, the readers of the AMERICAN MACHINIST, especially those who write for it, may all be so well informed on mechanical matters as not to be caught by such chaff, and entirely too busy to bother with it, even for amusement. Second, there is a natural disinclination on the part of a mechanic to have his name coupled with the subject in any manner whatever, and more particularly in public print. Third, the publishers may not have wished to mar their pages with illustrations of such devices.

Although these reasons may be good ones, the subject is an ever present one, and, therefore, a legitimate one for discussion. If some one with abundance of misdirected and uneducated ingenuity is not coming around to have such a device made, the mechanic is certain himself to come across problems, which, if carried to their legitimate conclusions, end in perpetual motion. The solution of such problems are not only interesting in themselves, but often convey valuable information, that will, at some future time, prevent serious loss.

The device shown in Fig. 1 came up some fifteen years ago, but has never been described. It is interesting, in that it seems to be different from any that have heretofore been described, but more especially in that it bears a strong resemblance to the famous one described by the Marquis of Worcester, but which no one has been able to make from the description.

The "machine" consists of an oval barrel, with the usual shaft and weighted arms. The shape of barrel is the peculiar feature. All that part to the left of a vertical line drawn through the center of the shaft, is one-half of an ellipse, whose center is the center of the shaft, and whose long diameter is co-incident with this vertical line. The other part of the barrel is a curve, constructed from this half-ellipse and the center of the shaft, and is so made that all diameters are of equal length. The method of drawing this curve is shown in Fig. 2. It consists in having a slotted lever working over a pin at the center of the long diameter of the semi-ellipse. At one end, *A*, of this lever is a tracing point, and at the other is a pencil point *B*, the distance between which is the long diameter of the ellipse. By causing the tracing point *A* to travel on the semi-ellipse drawn, the pencil point *B* will describe the required curve.

The shaft is made of large diameter, through which the weighted arms pass and are free to move endwise. The ends of these arms terminate in a fork, in which is supported a pivoted ball, as shown in Fig. 3, the object being to reduce friction to that due to rolling contact. By making these arms square they are prevented from turning in their bearings in the shaft.

The construction shows that there are always as many balls on one side as on the other, and that those on the right side are all further from the center than those on the left side. The question now arises, why will it not run? It will not do to say that the balls on the left side must be raised as far as those on the right side fall, and consequently those on the right have not the power to move those on the left. Although this answer would be strictly true from a technical point of view, it is a short-cut answer, and ignores the construction. What is wanted, and will do the investigator the most good, is an answer that will take the construction, and give the answer from it, instead of taking refuge behind a well-established and generally accepted principle.

The second device is hydraulic, and though the original question does not involve perpetual motion, it will merge into perpetual motion, unless a turning point be definitely determined and defined.

Suppose a tube of indefinite length, closed at one end and having a flaring mouth at the

other, be inserted in water, as shown at *A*, Fig. 4. Suppose, further, that a valve be placed in the pipe at the surface of the water, and that a perfect vacuum be produced in the upper part of the pipe. If now the valve be suddenly opened, how high will the water rise in this tube, if the atmospheric pressure is sufficient to support a column 34 feet long? It is quite evident that it will go above 34 feet, because the inertia of the moving body of water will not let it stop suddenly at this height.

Suppose at a height of 35 feet the tube bend over and discharge into a closed chamber, how much water will go over into this chamber, if the vacuum is perfect and the valve opened suddenly? Considering any given section of the rising column of water, it would seem that the removal of the water ahead of it, by falling over into the chamber, would allow its accumulated inertia to carry it over also, and each succeeding section in the same way. Looking at it in this way, it would appear as if the water would go on indefinitely flowing into the chamber, if only started in the manner described. If we are to believe some persons it would do so. For example, a mechanic (?) once assured me positively that he had pumped the water from mines by suction more than 34 feet (I forget how much more), by having a pump cylinder a good deal larger than the pipe, and by starting the pump suddenly. This would be the same as, though less perfect than, what is supposed in *B*, Fig. 4.

The argument is plausible; but let us see what it leads to when tested by what we know is true. As the water is supposed to flow over a curve, 35 feet above the supply, and into a chamber that would soon be full, we can furnish a convenient method of keeping the chamber empty by carrying a pipe down, as shown at *C*, and letting it discharge into a vessel, 34 feet below the bend. As this 34 foot column of water will balance the atmospheric pressure, it will maintain a perfect vacuum above it, as long as no air is admitted, as any surplus of water will simply run down and be discharged. If, therefore, a perfect vacuum, used to suddenly start a column of water, is able to keep water flowing to a height greater than atmospheric pressure would force it, then we have the anomaly of syphoning from a lower to a higher level, and having that, we have all the elements required to produce perpetual motion.

Everything that appears impossible, or, if actually accomplished, would appear to involve perpetual motion, is not necessarily what it appears at first sight. For example, a young man came into my office, and said that he wanted to construct a pump to raise wheat *by suction* 150 feet. As I knew that a cubic foot of wheat weighed nearly as much as water, and that individual kernels weighed more, I very promptly told him that it could not be done. He replied that he had just got through testing an experimental pump which raised it 125 feet, and now wanted one that would "stand the racket." As he was not able to give any intelligible reason *why* the experiment was successful, I put on my thinking cap, and soon found that, with a large, high speed pump, such a thing might be possible. The explanation is, that the wheat is not raised by suction, or rather atmospheric pressure, as water is, but the grain, being in the form of kernels, the air passes *through* it in a strong current, and the flow is so rapid as actually to blow or float the wheat upward, as comparatively large objects are carried in a tornado.

A New Cutter Grinder.

We illustrate with this a new form of universal cutter grinder, recently brought out by the Diebel Sewing Machine and Trimmer Mfg. Co., Philadelphia, Pa. The machine is designed to do every variety of cutter and reamer grinding, and is made with particular reference to the attachment of appliances for special work, such as surface and angle grinding. The spindle head can be swung around to any desired angle, and can be placed at a right angle with the position shown in the cut. In the place of one of the centers shown, a spindle head can be placed, the spindle driven from an independent countershaft for cylindrical or conical grinding.

The adjustment for taper and bevels is by means of the plate *E*, which is pivoted at the center, having a bearing on the slide *D*, which is graduated on the edge just above the feed crank *G*. The hand-wheel *F* moves the slide *E*—to which the work is secured—to or from the emery wheel. In Figs. 2 and 3 the cutter holder is shown in position. It swings upon its base to any desired angle, and can also be raised by a thumb screw to give the desired clearance in backing off cutters.

End and hollow mills can be placed in a chuck and ground by the same device. An attachment is provided for twist drills, which can be set at any angle and also adjusted vertically. The machine is furnished complete, as shown in cuts.

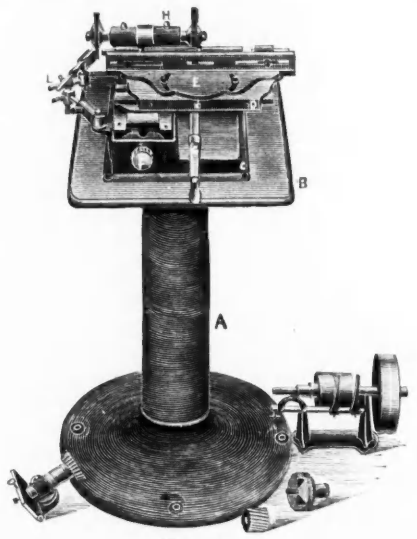


FIG. 1.

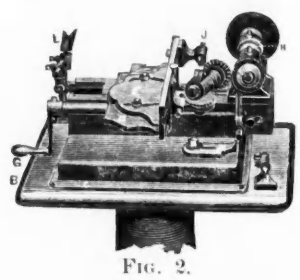


FIG. 2.

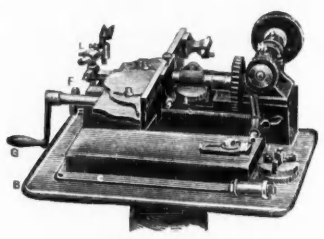


FIG. 3.

A NEW CUTTER GRINDER.

LETTERS FROM PRACTICAL MEN.

Melting with Coal and Coke.

Editor American Machinist:

As there has been a great deal of controversy in regard to the merits of coal and coke, for melting purposes, I offer, as of some interest, our experiences of the last three months.

In the first place, I will try and describe the cupola. It is a common 30" one, with 3 tuyeres, and made of staves of cast-iron. It is a very cheap way to build a cupola, as it can all be made in the foundry. Following are dimensions of cupola: Outside diameter, 41 inches; thickness of lining, 9 inches; inside diameter at tuyeres, 30 inches; inside diameter at melting point, 34 inches; inside diameter at charging door, 30 inches; height from bottom plate to bottom of charging door, 8 ft. 6 in. There are three tuyeres, about half-round, two on side and one at the back. The two side tuyeres measure in area about 78 inches, and the back one 14 inches, making a total of 92 inches.

The distance from sand bottom to bottom of tuyeres is 11 inches. The blast is furnished by a No. 4 pressure blower. The power is furnished by a water wheel; distance from the blower to the cupola, 180 ft. The blast pipe is 12 inches diameter, made with cement.

There is one drawback to the coke; that is, I think, that it melted the lining of the cupola out faster than coal. But a foundry having a brass shop connected with it can use the old pots to fix up the cupola with. The way I put them in is as follows: Put about ½ inch of daubing on, and then some of the broken pieces of pots, and plaster over them again as much as is necessary; and after the heat you will see the pieces of pots sticking out, and the clay from all around them gone.

Another thing I would suggest in regard to lining up a cupola; that is, don't throw away the old bricks. Have all the slag cleaned from them, and put them in the mill and grind them up and mix in with the daubing; it will save you a little in the course of a year or two.

It must be remembered that I do not put in the account of the workings of this cupola as a criterion, but just to show the difference in the melting with coal *vs.* coke. We make two test bars every day; they are 1 inch ogel, 33 inches long over all, 31½ inches between bearings.

The blast gauge that we have is a crude affair, but it answers the purpose very well. It is made of two pieces of ¼-inch glass tube, placed side by side on a board, with a rubber connection between them. It must be borne in mind that the pressure that is put down in the list is double the amount, as we measure the blast in the down tube.

It will be seen, by referring to the statement, that I have taken two separate weeks, so that the two weeks' melting would be about the same. There is about 200 lbs. difference in the amount of iron melted, but the difference between the coal and coke is 3,105 lbs. in favor of the coke, and very near 8 hours in the time of melting. It will be noticed that the blast pressure is higher with the coal, and, therefore, less blast will do with coke. There is another item connected with coke, and that is, it don't take above half as much kindling to light up the cupola with coke as it does with coal, and that is a great saving.

It must be borne in mind that I have no interest in coke ovens, but to see the men waiting around the cupola (shivering), waiting for iron, is enough to make a man feel sick, when the melting could be done in about one-half of the time with coal. Coke here is about the same price as coal.

THOS. WATHEY,
Supt. Foundry Dept. Eddy Valve Works.
Waterford, N. Y.

MELTING WITH COAL.

Date 1888.	Cupola.	Blast on.	Bottom Dropped.	Time.	Coal.	Iron Melted.	Average Iron to Coal for Week.	Mixture of Iron. No. 2 Cedar Point.	No. Hudson.	Hubbard Scotch.	Scrap.	Iron Tests.	Average Blast.	Power Used.
Mar. 26	30"	3.35	6.15	2.40	1500	7600		58%	12%	10%	20%	900-975	14 4-17	
" 27	"	3.20	6.15	2.55	1600	8000		70%	—	"	"	900-910	14 7-18	Water.
" 28	"	3.00	6.08	3.08	1700	8400	4 97:1	74%	—	"	16%	975-990	13 8-19	
" 29	"	3.10	6.30	3.20	1700	8400		"	—	"	"	1050-1047	13 3-5	Water
" 30	"	3.00	5.31	2.31	1600	8000		70%	—	"	20%	950-1000	15 11-15	and
" 31	"	3.00	5.45	2.45	1700	8400		"	—	"	"	980-1000	19 4-17	Steam
				17.19	9,800	48800								

MELTING WITH COKE.

Date 1888.	Cupola.	Blast on.	Bottom Dropped.	Time.	Coke.	Iron Melted.	Average Iron to Coke for Week.	Mixture of Iron. No. 2 Cedar Point.	No. 2 Spearman.	No. 1 Akron.	Scrap.	Iron Tests.	Average Blast.	Power Used.
July 16	30"	4.15	5.45	1.30	1120	8000		35%	35%	10%	20%	930-960	11	Water.
" 17	"	4.25	5.40	1.15	1100	7600		30%	30%	"	30%	900-930	10 3-10	"
" 18	"	4.15	5.45	1.30	1135	8000	7.15:1	"	"	"	"	930-960	11 1-10	"
" 19	"	4.00	5.45	1.45	1170	8000		32%	32%	"	26%	950-890	11	"
" 20	"	4.00	5.40	1.40	1150	8400		35%	35%	"	20%	930-970	10 2-5	"
" 21	"	4.00	5.45	1.45	1120	8000		"	"	"	"	915-940	9 7-11	"
				9.25	6795	48600								

Boiler Furnaces—Cut Gears—Steam Motors on Surface Roads—Mr. Dorsey's Comparison of English and American Railroads.

Editor American Machinist:

It is pleasant to endorse Mr. Peter H. Bullock's remarks on boiler setting.

As he very rightly says, boiler setting is now almost identical with what it was twenty years ago, except that more room is allowed in furnaces and flues. How painfully small was the height from lower sheet to the grate bar, none but an inspector could properly appreciate; and in my own practice I have always fixed 24 inches as a minimum in externally fired boilers. Experience in flue or internally fired boilers has taught me also that combustion is more perfect in large than in small furnace tubes, all which is on the lines advocated by Mr. Bullock.

In the local press of this city there has recently appeared, and is still appearing, a considerable correspondence on the question of smoke and its prevention. Many of the writers who urge the stricter enforcement of the "act for the prevention of noxious vapors," are from persons interested in the sale of some patent smoke prevention apparatus, and hence of little value.

The smoky state of English towns is very apparent to me, after a year's residence in New York, and I have felt some interest in the subject, and enclose you a letter I sent to one of the daily papers on the subject of smoke, wherein special attention is drawn to the evil of complication in steam boilers, and the mistake made by boiler makers in adding useless and obstructive water pipes in the internal iron flues of Lancashire and similar boilers, under the impression that they are conducive to economy, whereas, in fact, they are a cause of smoke, by the check they place on the combustion of the gases evolved from the fuel. As regards bridges, they may often be dispensed with entirely, but in flue boilers, if the area over the bridge is about one-twelfth the fire-grate area, very good results may be obtained in combustion. All the foregoing remarks apply, of course, to furnaces using bituminous coal, and must not be taken as applicable to "hard" coal, for which, it seems to me, that many furnaces would be suitable that are wholly unfitted to bituminous coal, the hydrocarbon gases from which are the cause of all the difficulties of perfect and smokeless combustion.

Sectional boilers appear highly suitable for hard coal, but have never appeared to me as suited for smoking coals.

Now, as to the question of cut gears for lathes, etc., I see that Mr. Claugh takes me to task in this matter, and I will just take his objections seriatim. First he says, "Exceedingly few gear patterns have been made as accurate as gears cut by first-class machinery." He is right, no doubt, but I asked for gears cast from accurate patterns, and have been accustomed to patterns every bit as accurate as the best cut gears, and made, in fact, on a dividing engine with an accurate wheel of 360 teeth.

To his second I reply that a careful moulder will not produce appreciably inaccurate wheels.

To the third I am inclined to the belief expressed some weeks ago by another correspondent, that American irons have a greater or more variable shrinkage than the irons to which I have been accustomed. Can any one tell us if this is so?

Fourthly, as to chucking for boring, the cleaned casting should be chucked by its rim and lowest side, and Mr. Claugh may keep all the eccentricity he can find.

Finally, as to the question of wear, upon

which I claim really such merit as cast gears possess. Granted that cast gears have an initially thinner tooth—what of this? Lathe gears are not wanted, like many other gears, to last until worn too weak to do their work. My own idea of lathe gears is that they should have as little initial play as possible, and never an appreciable amount more. If a lathe is allowed to run until its gears begin to break from weakness, is it not likely that the owner of the lathe is keeping it because it was one that his grandfather used as a boy?

A lathe ought rarely to outlast its gears, and hence the advantage that the gears should be practically perfect when the lathe is done.

I cannot agree with Mr. Claugh's final remarks as to the sandy surface of cast gears. This is not at all a necessity.

But I must conclude by saying that it is only of first-class work that I have been speaking, and, after all, why should not work be always first class when called for? I have seen castings—not gears—in America which certainly showed a surface suitable for gears, clean and smooth as any English casting.

There is a point in casting gears requiring special attention, and that is the temperature of the molten metal as poured. If too low, the casting is imperfect and cold shut, but if too high, the sand *does* get burned in deeply. Clearly the proper mixture to use is one fluid at a low temperature. Needless to say, the mould requires well blacking and careful, uniform venting.

Are there no steam motors on the surface roads in America? If not, why? Here they are common enough. The street cars in Leeds have been worked for years by small engines with atmospheric surface condensers, and steam motors may be seen in Wigan, Burnley, Birmingham and other large towns in the pottery district of Staffordshire. Stoke on Trent and the adjoining towns are connected by steam trams, and similarly the group of towns, Manchester, Bury, Oldham and Rochdale, are joined by steam on the common roads, apart from the railroad surface. The steam motors ascend gradients of great steepness, with heavily loaded long cars.

Now, if these steam drawn cars are admissible in the towns here, which often have very narrow streets, why should a cruel prejudice in favor of horse-flesh exist in the United States?

Atmospheric condensers are very efficient, even in this damp climate, and steam is rarely seen. I fear, however, that hard coal would be very unsuitable, from its extreme dustiness.

I note you refer to Mr. Dorsey's paper, comparing English and American railroads—incomparable quantities—and I venture to say that, when the United States contain nearly two thousand million inhabitants, which is about the density of population in England alone, the railroads of the States will have cost quite as much per mile as the English roads, which are costly of very necessity, and were not built in a costly manner out of choice. At the same time there are lines in this country, which, beyond station accommodation and cost of land, have not cost anything beyond the track and ballasting, side ditching and fencing. American experience, as exemplified in Jersey city, has proved the wisdom of the construction adopted in England, and the towns are rare where the railroad is not either 20 feet below or above the street grade, as they will yet have to be in America. Railroads here were built through a crowded country, and built accordingly. It would be folly to build a railroad in a sparsely settled country on similar lines, and no doubt a gradual bringing up to solidity, as required, will prove cheaper than an initial first-class construction, which has been so great a hindrance in some respects, such as car sizes, in England. Your readers will readily appreciate these points. The danger of cheap and grade constructions lies in the delay which always occurs in improvements, and its accompanying waste of life at street crossings, and by weak bridges, etc.

It is remarkable that it is only within the last ten years that any considerable reinforcement of bridges has been required in Britain, though these were constructed at a time when locomotives weighed fifteen or twenty tons. It will be observed in Mr. Dorsey's paper, that he is apt to look on the commercial work of a locomotive as a measure of its mechanical duty, the facts being that an English locomotive probably performs as much work as an American in gross weight moved. The mechanical efficiency cannot be measured per pound of paying load carried, but per pound of paying load, car body, wheels, axles, couplings and brake blocks, etc. The question is not one that can be treated on such narrow lines of thought at all. Great loads can only be transported long distances cheaply at a low speed. To do this has been solved by American engineers and traffic managers. In England there is practically no hauling to be done. A freight wagon is loaded one day and back again the same or following day. Expenses are largely terminal. By high speeds the freight traffic between two towns is served by one-half the number of wagons that would be required by a slow traffic. Wear and tear may be greater, but whether wear is less and congestion of traffic less, terminal expenses being the same for all speeds. Your excellent remarks on statistics very appropriately follow those on Mr. Dorsey's paper. Figures may be manipulated to prove anything, but statistics are useless, unless one knows all facts. Now, what would be the utility in using heavy freight engines to run light freight trains? A freight engine as standard here weighs perhaps 80,000 pounds, and is ample for its work. Long and heavy freight trains are not used. They are not needed or conveniently workable, for the exigencies of traffic preclude this.

I have dwelt thus lengthily, because it seems desirable that a check should be put to the attempts made here and in America to draw comparisons between incomparables. Such attempts only defeat their own end, and teach nothing. The United States have nearly seventy-fold the area of England alone, but only double the population, and perhaps six-fold the mileage of railroads. Can any useful comparison be drawn between such dissimilar facts?

W. H. BOOTH.

Arrangement for Shop Work-Benches.

Editor American Machinist:

It has seemed to me that there is an opportunity for improvement in the arrangement of work-benches for vise-work, along the windows of a shop. Fig. 1 shows, in a plan

Fig. 1.
Common Arrangement.

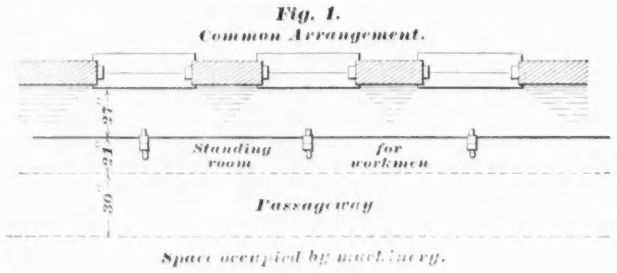
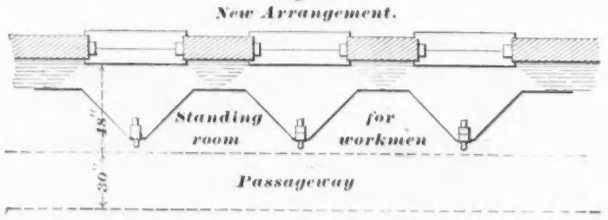


Fig. 2.
New Arrangement.



view, ½ inch to the foot, the usual arrangement; Fig. 2 shows the arrangement I have to propose. The primary object of the design is to give the workman a better chance to see, and to work upon anything held in the vise on the sides lighted by the window, and to obtain in a more convenient manner an opportunity to work on several sides of work thus held. The other considerations involved in planning a convenient work-bench have not been overlooked, as will be seen on comparing the two figures. The space on the bench that is properly lighted is as large in the new arrangement as in the old, and the dark space between the windows, where the tool chest is usually quartered, by being narrower will make the chest more accessible. The new arrangement gives as much room for the workman to stand as the old one. It also places him where he is not as liable to be interrupted by being crowded against when machinery is being moved along the passageway; and the saving of time as well as the lessening of work spoiled through men, in going along the passageway, knocking against elbows of the vise hands, will more than offset any increased expense in the new form of construction. An inspection of the plans will show that neither the width of the passageway nor the floor space available for other purposes has been reduced in the new arrangement.

B.

Loss of Power by a Sticky Belt.

Editor American Machinist:

A certain engine running at 200 revs. per min., has a driving pulley 48″ dia. and a 20″ double belt. The belt and the pulley surface have become very sticky, and when the engine is running the noise of the belt tearing away from the pulley can be heard at the farther end of the shop. Who of your ingenious correspondents will suggest the best way of computing the loss of power from this cause?

FRANK RICHARDS.

It is Curious.

Editor American Machinist:

The *Atlantic Monthly*, published under the shadow of Harvard University and the Institute of Technology, has its pages for February brightened up by the following gem, which may interest your readers:

"No doubt many of our readers have wondered why the Romans spent so much labor on the construction of these massive works (aqueducts). . . . It was not that the Romans were ignorant of the siphon, . . . but simply that no pipe, except one of cast-iron, could have borne the enormous pressure of *fifty-four million cubic feet of water every day*, and that the Romans had no cast-iron."

Your readers will no doubt be pleased to know that cast-iron pipes will stand such a "pressure" "every day."

WM. H. HARRISON.

Braintree, Mass.

Tubular and Water Tube Boilers.

Editor American Machinist:

In your edition of Jan. 10 I notice a query from A. K. J., Omaha, Neb., in regard to the relative efficiency of the water tube and return tubular boilers. The answer there given is correct under the conditions of pure water and anthracite coal. Here in the West we do not commonly have either of these conditions, and my opinion, based on several years' experience with both kinds of boilers, under continuous and severe service, is that in this part of the country the inclined water tube boiler is the more efficient and durable. I judge from an engineers' standpoint, as I have no financial interest whatsoever in either kind of boiler.

The return tubular is the standard boiler of the West, it is true, but it would be hard to find one evaporating 8 pounds of water per pound of combustible. Two tests that I know of, made under regular working conditions, gave about 5 pounds and 6 pounds of water per pound of combustible respectively, and three tests of a well-known water tube boiler that I made myself, under working conditions, showed 7.28, 7.63 and 7.63 pounds of water evaporated from and at 212° F. The coal used contained 25 per cent. of refuse, and may be taken as an average of ordinary Western soft coal.

In the return tubular boiler, using this coal for fuel, a great deal of soot is deposited on the bottom of the boiler and inside the tubes; in the latter it soon checks the draft, and, as the rule is, the less draft the more soot, it soon impairs the steaming power of the boiler.

Though the water tube boiler is not free from the soot nuisance, yet its evaporative efficiency is not so seriously impaired by it, as soot does not adhere so readily to the outside of a tube as to the inside, and therefore cannot check the draft to any serious extent.

Another disadvantage of the tubular boiler is that, in using hard water, the inside of the shell and outside of the tubes soon become coated with scale, and it is practically impossible to clean them without taking out the tubes, which is a delightful job, also expensive.

The water tube, by reason of the rapid circulation, does not scale nearly so readily, and, as provision is made in well-designed boilers of this class for getting at and scraping each tube, they can be kept in good condition with proper care. This accessibility would, in my estimation, be a recommendation to any boiler, for internal scale is *the* curse of a steam boiler, and can almost equal an ignorant fireman in hastening its destruction.

W. L. HARDY.

Ottawa, Ill.

Boring That Cylinder.

Editor American Machinist:

There is little doubt in my mind about Mr. Platt arriving at the cause of his trouble, had he bored a cylinder and fed up the carriage in the opposite direction—that is, towards the tail stock instead of from it—when he would have found the order of things reversed, the large end being next the face-plate.

It is a number of years since I had a similar difficulty to overcome, and as I never cared to allow a machine to have the upper hand, I bored in the opposite direction, with the result mentioned above. I then came to the conclusion that the difference in the bore meant the loss of keenness of cutting edge of the tool, which gradually increased the resistance of the metal, causing sufficient spring to throw the cutting edge off the center line, which must result in the hole being taper.

As a remedy I used two cutters, and the difference in the ends was barely perceptible when calipered.

JOS. A. ROTHWELL.

Cost of Oiling an Engine Cylinder.

Editor American Machinist:

The following data was handed me by a careful engineer—one of those fellows who like to know how much coal, oil, and waste cost. I think such are comparatively rare, and do not remember to have ever seen in print the like showing. Perhaps, though, from a small plant, the showing will be appreciated. Here is his paper:

Bought 1—10—'88, 26.5 galls. cylinder oil @ 36c.; used 7.5 galls. for other purposes than cylinder; 19 galls. used in 234 working days of 8.5 hours; 1 gall. used every 12.33 days, or every 104.8 hours; 1 gill (cost 1.-125 cent) used every 3.27 hours. Engine, 12″x24″, slide valve, 440 feet piston speed, steam-set packing rings. B. P., 75 lbs. Throttling governor.

The cheapness of oil will be noticed, and yet, after all that is said about high-priced oil, it is doubtful if this record can be excelled, either in cost per hour or in the condition of valve, seat, or cylinder.

DUPLEX.

The compound locomotive for the P. R. R. has arrived from England, and with it a machinist to put it in running order, and an engineer to run it. This ought to insure fair treatment, so we may look at results with the assurance that all will be done that is possible to do to make this engine a success on American roads.

Shop Notes.

One of the remarkable things about the establishment of Bradley & Co., of Syracuse, N. Y., is the wide variety of work turned out in it. They not only make all kinds of vehicles, including wagons and buggies of every description, even Sterling Elliott's spring wheelbarrow, but reapers, mowers and many varieties of belt-driven power hammers; a range in products not often met with in a single establishment, although, of course, wherever the nature of the work requires it, it is done in separate departments.

In their blacksmith shop, as might be expected, one will find the art of turning out work by the use of the power hammer reduced to a science. One of the noticeable points being that the hammers in their own shop run at a higher rate of speed than the same hammers are run in other shops; a 25-lb. hammer, for instance, being run here at 550 strokes per minute, which is much faster than they usually recommend them to be run by others. A good example of the conversion of energy into heat is here shown to visitors, by taking a piece of cold iron, about ⅝ round, and drawing it down quite small under a trip-hammer, the force of the rapid blows furnishing the necessary heat, and making the iron at last red-hot.

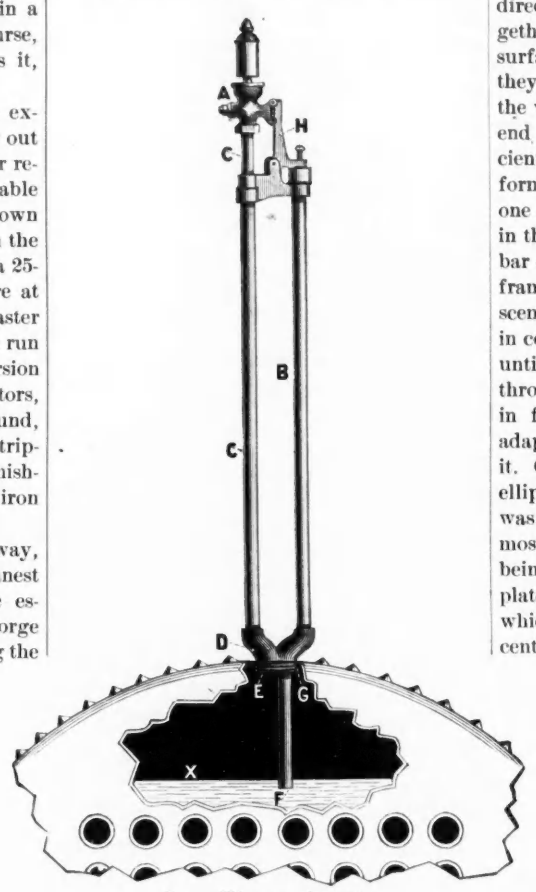
Their new smith shop is a model in its way, being one of the best lighted and cleanest smith shops to be seen anywhere. One especially pleasing feature is that the forge chimneys are all in the side walls, leaving the space within the shop entirely unobstructed. This plan would, of course, not be adapted to some kinds of work, but answers for the work done in this shop, which is all quite small; the heavier work being done in another department.

In one corner of the machine shop they have a Worthington duplex pump, which pumps the water for ordinary consumption about the works, and is connected with the system of pipes used in case of fire. The speed of the pump is regulated automatically by the pressure in the pipes, and the fact that its speed is increased by drawing any unusual amount of water from the pipes is taken advantage of to secure a very effective automatic fire alarm. At a height of about five feet, and above the rocker-arms, which work the valves of the pump, is suspended an old-fashioned bell with a swinging clapper. To one of the arms of the valve motion is attached a flat steel bar, in such a manner that it stands up above the pump to a height sufficient to reach the end of the bell clapper. By the movement of the arm to which it is attached, it vibrates back and forth, to and from the bell, not quite reaching the clapper, however, under ordinary conditions. But the bar is light enough, so that, when the speed of the pump is increased beyond a certain limit, the bar vibrates beyond the point to which the motion of the arm would ordinarily carry it, and, when this occurs, strikes the bell clapper at each stroke of the pump, causing the bell to ring, and not only calling the attention of those who may be about the building, but also calling out the city fire department, one of its engine houses being located across the street, and within hearing of the bell.

The power hammers made here are finding a market in foreign countries, amongst the recent shipments being six hammers to Melbourne and two to Leeds.

At The Sweet Mfg. Co.'s place many interesting things are to be observed, amongst others, a very efficient method of working up old steel rails into other and various forms of usefulness. A rail being heated in a furnace is passed between rolls, which divide it longitudinally into three parts, the central web being cut out in such a way as to form a flat bar, leaving the flange and the top of the rail at each side to be afterwards rolled or forged into other forms. A curious thing about this process is that the sharp, cutting edges on the rolls, which cut into the center web, do not come together sufficiently close to actually separate it from the other parts of the rail, but merely cut into it part way on each side, the actual separation of the parts of the rail into three bars being due to the fact that the web is rolled out longer at the same time, which is not the case with the other two parts; the central bar being considerably longer than the other two, as they come from the rolls.

At the other roll trains, where these bars are afterwards rolled out into the required shapes, are to be seen what are called the



LOW WATER ALARM.

"rat holes." These are long tubes, sunk slightly below the level of the floor, and extending out at each side of the roll train to a distance equal to the longest bars rolled. The ends nearest the trains are a little behind the men, and have enlarged openings, into which the roller guides the bar as it comes from the rolls. The floor is, by this means, kept entirely clear, the bars are kept straight, and there is much less danger of accidents to the men. It is a cause for wonder that these "rat holes" are not generally used in rolling mills. After seeing them in use, one can hardly fail to be impressed with the fact that they possess some decided advantages over the usual method of letting the bar run over the surface of the floor, at the risk of coming in contact with some obstruction, or winding about one of the men.

An ingenious machine for bending bars of steel to various forms is to be seen here, and consists simply of an iron form which corresponds to the lower die of a drop-hammer, upon which the heated bar is laid and pressed down to fit it by numerous flat plates of iron, which are about ⅜" thick, and stand side by side in contact with each other above the former in a supporting frame, in which they are movable vertically, but in no other direction. Enough of these plates stand together in the frame to extend over the entire surface of the former. At the lower end they are square, and about equal in width to the width of the former, though at the upper end they are made wider, to give them sufficient weight; the thickness remaining uniform throughout. Arranged as they are, any one of these plates may be shoved upwards in the frame without moving the others. A bar of steel being laid upon the former, the frame carrying these plates is allowed to descend; the ends of the plates, as they come in contact with the bar, forcing it downwards until it comes into contact with the form throughout its length, the plates constituting, in fact, a universal adjustable die, which adapts itself to fit any former placed beneath it. One of these machines, in use for bending elliptical springs for the seats of farm wagons, was doing the work in what seemed to be the most efficient manner possible. The former being highest in the middle, the descending plates first secured the bar at that point, after which successive plates each side of the center brought it down to fit the former, leaving the ends free until the last moment. So quickly is this done (and also, perhaps, partly owing to the fact that the plates touch the steel at intervals only,) that the same heat at which they are bent to shape suffices to temper them, they going directly from the former into the tempering bath. Vast quantities of these springs are made here, and, as a result of the fact that they are made from bars which originally were parts of old steel rails, and also of the fact that the methods employed in their manufacture are exceedingly ingenious and efficient, they are actually sold at a price lower than one could buy the bar steel, suitable for making them, in the open market.

Great numbers of crowbars are also made,

POWER SHEARS.

and in the forging of these crowbars into shape under a steam hammer is seen a good example of the extreme precision of eye and hand attainable by long practice at the same work. The uniformity of size, shape and weight, in the square part at the end, in the octagonal portion above this, and in the round, tapering, upper part of a lot of these bars, as they lie side by side, is something astonishing, and almost incredible, when it is considered that they are forged with flat, plain-faced dies, and finished without the application of any gauges whatever, either for diameter or length, their uniformity depending entirely upon the eye of the hammerman.

The Hardwick Low Water Alarm.

The engraving on this page shows the latest, and, we believe, the most simple low water alarm yet devised. It is claimed for this alarm that it will operate "as surely as water will run down hill"—a claim which, though it sounds rather extravagant, seems not unreasonable when its mode of action is considered.

In attaching this alarm to the boiler, all that is necessary is to drill and tap one hole in the top of boiler, to fit 1¼" pipe thread. Into this hole the casting *D* is screwed. This casting has two holes through it, into one of which a pipe is screwed, reaching down into the boiler to the lowest point to which it is desired the water line shall fall. This pipe is thus placed in direct communication with a copper pipe *B*, the upper end of which is closed, and comes in contact with a set screw in the lever *H*. The other opening in the casting *D* communicates with the iron pipe *C*, to the upper end of which the whistle *A* is attached.

When the boiler is under pressure, and the water line above the lower end of the pipe *F*, as shown, this pipe and the copper pipe *B* will stand full of water, which, owing to lack of circulation, will be comparatively cold. But as soon as the water line falls below the end of the pipe *F*, the water will run out of the copper pipe *B*, and it will immediately be filled with steam, which, by heating it, will cause it to expand, and, by means of the lever *H*, open the whistle valve.

The screw in the lever *H* is adjustable to make the whistle blow at any desired increment of temperature. It is thus seen that this is a device of remarkable simplicity, and that its action is sure, since there is nothing about it which can well become deranged, or cause a failure to act.

It is, of course, unnecessary for us to say anything to our readers regarding the desirability of a low water alarm, if only one can be secured which is known to be reliable, and this one seems to attain as near absolute reliability as possible.

It is made by The Fox Machine Co., Grand Rapids, Mich.

Power Shears for Bar Iron.

The accompanying engraving represents a shearing machine built in six sizes, by the New Doty Mfg. Co., Janesville, Wis.

They are built especially for cutting bar iron—round and flat—the smallest weighing 600 pounds, capable of cutting 1" round iron and 3"x½" flat iron. The largest weighing 10,000 pounds, capable of cutting 3" round and 6"x2" flat iron.

As will be seen, the machine consists essentially of a shear lever moved by a cam, which is on a shaft passing through under the lever. This shaft is driven by suitable gear wheels from a second shaft, which carries the fly-wheel, the clutch and driving pulley.

The blades for cutting flat bars and those for round iron are on opposite sides of the lever fulcrum, both being always in place and ready for use.

The gearing is proportioned ten to one, and all the parts are made amply strong to resist the greatest strain which can be brought upon them.

A daily paper, in setting forth the merits of a new locomotive that is to do 150—ordinary speed—miles an hour, says: "The rotary force is applied at the great driving wheel [12 feet diameter] by a crank, at the same point as it is applied by the foot on the pedal of a bicycle, thus giving great leverage power." That settles it, of course. Whenever in mechanics it is possible, by "great leverage power," to get more out of a machine than is put into it, there is no limit. Just as well make the speed an even 200 miles.

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Regarding Steel.

No one having had experience in machine shops will question the fact that the proper selection and management of the steel out of which shop tools are made is a matter of prime importance, and, in fact, often does more than any other factor in determining the success or failure of an undertaking. And yet we feel bound to say that, in a large majority of shops, this question does not receive anything like the attention its importance entitles it to. If the owner of a machine shop becomes convinced that, by replacing one of his old machine tools by a new and improved one, he can increase his output twenty per cent., he usually buys the new tool, if he possibly can; and yet we feel very confident, as the result of some experience and considerable observation in shops, that there are many of them in which the output of work, from nearly every machine tool, could be increased twenty per cent., without any additional outlay whatever, simply by the devotion of a little more intelligent thought to the question of the selection and management of tool steel.

It is important, in this day of close competition, to have the shop equipped with the best machine tools; but, as the capacity of the best machine tools is limited by the strength and endurance of the cutting tools used in them, it ought to be apparent that the securing of the best cutting tools is a matter of equal importance.

And it should be constantly borne in mind that, while the price at which steel can be purchased is usually a pretty good indication of its quality, it is no indication whatever as to its adaptability to any certain specific purpose. It is far too common to consider good steel as good for every imaginable purpose, without regard to any other quality whatever, whereas it ought to be well known that, of two bars of steel of equal quality, and that the highest, from the same maker, and sold at the same price, each bar may be excellent for certain purposes for which the other would be nearly, if not utterly worthless. The reason for this is, not that the one is of better quality than the other, but that they are intended and made for a different purpose, and to condemn either because it will not do what the other was made for, is as irrational and absurd as to condemn an excellent and well-built drill press because it failed to turn shafting.

The purer and better the iron, the better the steel made from it, and the higher the price at which it must be sold; but, after the quality is secured, then the adaptability of any given bar to any certain purpose depends upon the "temper" given it by the steel maker, and this temper is determined by the amount of carbon put into it, and is entirely and absolutely independent of the quality.

It ought to be a self-evident fact that the best quality of steel cannot be sold for less money than must be paid for the iron out of which such steel must of necessity be made; yet there is abundant evidence that this simple fact is overlooked very often, as is also that other fact, that, where a tool is to be made which will require five pounds of steel and a hundred dollars' worth of skilled labor to produce it, it does not pay to attempt to save a few cents on the cost of the steel, at the risk of losing a large part, if not all of the labor. For such tools the best obtainable steel is none too good, and has repeatedly been proven to be the cheapest.

But whether the quality of steel be of the best or the worst, the fact must never be forgotten that its "temper" must be suited to the particular purpose for which it is used, or no satisfaction can result.

It is an undeniable fact that more dissatisfaction and trouble with steel results from unfortunate guesses by the steel maker as to what a given bar furnished by him is to be used for, than from any other cause, with the possible exception of the abuse which it often receives in the smith shop.

Too many users of steel will insist that good steel should be good for any purpose, and they cannot be induced, when ordering steel, to specify the purpose it is to be used for; then the steel maker must guess at that purpose as best he may; if his guess is a lucky one, the steel gives satisfaction; if unlucky, it is condemned.

The steel makers usually make these guesses from the line of business of the customer, and from the size and shape of the bars ordered, and in many cases are able to hit it, but cannot hope to do so in all cases; and when they fail to make the correct guess, experience has taught them that they will not usually be accused of being inaccurate guessers, but of making poor steel, when in fact the *quality* of the steel has had little or perhaps nothing whatever to do with it.

The fact cannot be too strongly impressed upon the minds of steel users, that it does not pay to have the steel maker guessing in this way, when by taking very little pains, and at little or no expense, steel could be furnished, each bar of which would be adapted to its particular purpose, though, of course, it would be necessary to keep the different kinds separated and properly designated in the smith shop, instead of having it altogether in a promiscuous heap, and cutting from the same bar, steel for a tap, a punch, an arbor, a milling cutter, or a drill.

Where large quantities of steel are used for a single purpose, as in the manufacture of edge tools, axes, springs, pitchforks, etc., very little trouble is experienced with the steel, and uniformly satisfactory results are usually attained.

Though this is due partly to the fact that the establishments making such things do not spare pains nor expense to insure uniform and proper treatment of the steel, in forging and tempering, yet it is due in greater measure to the fact that the makers of the steel know just what it is to be used for, and if not at the first trial, then after one or two preliminary trials, they furnish steel of precisely the right temper for the purpose.

No machinist would think of sending an order to a tool builder for a machine to weigh so many pounds and to cost so much money, without specifying what kind of a machine was wanted, nor whether it was to be used for turning pulleys, drilling holes, or planing; and yet such an order is closely paralleled by orders received by steel makers from machinists every day.

What is wanted more than anything else is a better mutual understanding and more frequent consultations between steel users and steel makers, as to the best kind of steel to furnish, and the best manner of treating it, after it is furnished.

Statistics by Machinery.

Among the patents recently issued are three to a New York man upon a machine for compiling statistics. It is really difficult to imagine what we have missed by the fact that that machine was not perfected and put into use previous to the recent presidential campaign. And the fact that it is patented now affords an explanation of some things which before were difficult to understand. We had been puzzled to account for the large amount of absurd and contradictory statistics which were paraded before a long suffering public. But we understand it now. This machine, like all other new mechanical inventions, had to be put through the testing process, and the necessary modifications and changes made as the various inevitable imperfections were developed by the practical tests to which it was subjected.

This machine was undoubtedly being tested and perfected just during the height of the campaign, and the statistics which came so near making us a nation of madmen, were the result of its naturally imperfect, not to say crude action.

On one day it would grind out a lot of statistics proving conclusively something or other. The next day it would be noticed that the machine had slipped an eccentric, or was a little "out of time" from some cause, and with this defect remedied it would grind out a table proving beyond the shadow of a doubt that what it had proven the day before was wrong. Every machinist will understand this. No machine embodying a new principle can be expected to work perfectly at first. But before the next campaign occurs, there will be time to organize a syndicate, which, with this machine, will furnish all our statistics, and, as the machine is now probably fully perfected, we may expect the statistics to be entirely reliable and consistent, their particular complexion depending solely upon which party succeeds in controlling the syndicate.

We commend this machine to Mr. Edward Atkinson, in the hope that, by its use, he may be able to better explain some of the mysterious things pertaining to his work, by which, if we understand him aright (of which we have very serious doubts), he demonstrates, for instance, that a laborer working in New England can, by a few hours' work, earn sufficient to pay the freight charges on his year's food supplies brought from the West, whereas, at one time, he would have been obliged to haul them himself, thereby consuming several hundred times more of his time. Therefore the laborer is several hundred times better off than he once was.

We also commend this machine to the editor of one of our mechanical contemporaries, in the hope that, by its use, he may possibly be enabled to distinguish the difference between a table of statistics and a lot of letters from the master mechanics of the country, regarding their practical experience with steel for locomotive crank-pins.

In short, we think this machine will fill a long-felt want, and with a statistic syndicate to prove anything which we may desire to have proven, and Stockton's war syndicate to fight our battles, we cannot see that there will be much more to be desired.

Literary Notes.

The January number of *The Manufacturer and Builder* comes to us in a new cover of a delicate corn color. The cover is very nicely ornamented with various representations of industry personified, and is otherwise neatly gotten up. Our contemporary evidently believes in a cover, and believes that what is worth doing is worth doing well.

Combustion in Locomotive Boilers is the title of a little book by Angus Sinclair, published by the *National Car and Locomotive Builder*, New York. The author, in his preface, claims utility for his book only in connection with locomotive enginemen, but we think he is quite too modest in his claims. While as a locomotive fireman and engineer, he has studied combustion more especially in connection with the locomotive, yet the underlying principles of combustion are the same wherever coal is burned. To those who are acquainted with the writings of Mr. Sinclair, it is unnecessary to say that these principles are so plainly stated that none need err in following them out to their legitimate conclusions.

Combustion in Locomotive Boilers is a book we have no hesitancy in recommending, not only to locomotive firemen and engineers, but to stationary and marine firemen and engineers, and in fact to every one who has occasion to burn coal.

The price of the book is only 25 cents.

MODERN HELIOGRAPHIC PROCESSES: A Manual of Instruction in the art of reproducing drawings, engravings, manuscripts, etc., by the action of light. For the use of engineers, architects, draftsmen, artists and scientists. By Ernst Lietze, Mechanical Engineer.

In this book the author treats on the various methods and processes by which drawings, manuscript engravings, etc., can be reproduced in the same size as the original, by the direct action of light. The book contains an interesting chapter on the chemical and physical action of light, showing to some extent the effect which light will have on organic and inorganic bodies. The processes given are those by which white lines on blue ground, and blue lines on white ground can be obtained, besides the processes by which other shades of prints are produced. These different processes are classified with reference to the sensitive substances used, as follows:

1. Processes with salts of silver.
2. Processes with iron salts.
3. Processes with salts of chromium.
4. Processes with salts of uranium.

The necessary outfits for the different processes are also described and illustrated. The book contains thirty-two illustrations on wood, and ten specimen heliograms. It also has a table of chemicals used in the processes, giving the French and German names of these chemicals, their molecular weights, molecular formula, composition, average price, and remarks relating to their principal properties and their preparation; altogether making a book of 137 pages. The author is evidently familiar with the subjects on which he writes, and presents them in an interesting manner. Engineers, draftsmen and others interested in the reproduction of drawings, etc., will, we believe, appreciate the work, which will form a valuable addition to their library. The price of the book is $3.00. It is published by the D. Van Nostrand Company, New York.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(47) C. M., Kansas City, writes: Can you tell me of some way to put the bluing on steel and iron similar to the fine bluing on rifles? *A.*—One way of doing such work is by applying nitric acid and letting it eat into the iron a little, when it will be covered by a thin film of oxide. Then clean it off, oil and burnish.

(48) J. C., Bad River, Wis., asks: Will you please tell me what steam is? One writer says it is an elastic fluid resulting from the combination of heat with water; another says, it is water changed by means of heat into a gas. *A.*—Steam is a vapor into which water is changed by the absorption of heat. We may look upon steam as an aëriform body, in which the particles of water mutually repel each other, and are further apart than when they form a liquid. Steam has the property of indefinite expansion which characterizes gases.

(49) Anxious, Brooklyn, N. Y., asks: What is meant by direct and indirect acting locomotives? *A.*—If the terms "direct acting," or "indirect acting" refer to the motions of the cranks, connecting rods, etc., we should call all locomotives direct acting engines; see answer to Question 535, in our issue of Dec. 15, 1888. If these terms refer to the valve motion, then we should class all locomotives which have their eccentrics on the main axle, with direct acting engines; locomotives which do not have their eccentrics on the main axle we should class with indirect acting locomotives.

(50) J. S., Atlanta, Ga., writes: Please let me know the rule adopted by the M. M. Association for counterbalancing locomotive driving wheels. If this association has not adopted a rule for this purpose, and if you have published one, please let me know in what issues of your paper I can find it? *A.*—We are not aware of any rule for counterbalancing locomotive driving wheels which has been adopted by the Master Mechanics' Association. You will find the methods for counterbalancing driving wheels thoroughly explained and rules given in our issues of Feb. 18, March 3, 17, 31, April 14, 28, May 12, 26, June 9 and June 23, 1888.

(51) W. H. H., Quincy, Ill., and A. U. L., Pittsburgh, Pa., ask similar questions, namely: Will you please let me know how to prepare the solutions used for blue prints with white lines on blue ground; with blue lines on light ground; and also red lines on white ground, if there is such a process? *A.*—For blue prints having white lines on blue ground see answer to Question 449 in our issue of November 5, 1887; see also article on this subject in our issue of January 29, 1887, page 1. There are several processes for obtaining blue lines on white ground, but none of them are as simple as that for obtaining white lines on blue ground. Some of the former processes are patented; one which is not patented is given in our issue of January 22, 1887. For processes used for obtaining other colors see book noticed in Literary Notes in current issue.

(52) Lee Whitaker, Newport, Ky., writes: I have a wooden tank 16 feet diameter, and 7 feet deep, which is filled with water. If I place a stick of wood in the center of the tank, will this prevent the bursting of the tank if the water should freeze? If it does, what is the reason? Please answer this question to settle a dispute, as I have charge of three water tanks, and have been told to place pieces of wood in them, to prevent ice from bursting them. Not having any faith in the remedy, I write to you for information. *A.*—This, to us, is a new idea, and while, like our correspondent, we have not unlimited faith in it, yet it might be possible there is some virtue in it. Perhaps some of our readers can throw some light upon the matter. If such simple means will secure exposed tanks from this danger, there are many other engineers who would like to know it.

(53) W. B., Marion, O., asks: 1. Is there any other name for red prussiate of potash? *A.*—We do not know of any other name for it. 2. Is the solution I sent you put up right for blue printing? It has been put up according to your answer to Question 449, in your issue of Nov. 5, 1887. *A.*—The solution you have sent seems to be only a solution of red prussiate of potash, without the solution of citrate of iron and ammonia mixed with it. 3. Is there a paper prepared for blue printing? *A.*—Yes; but you should not have any difficulty in preparing the paper yourself, if you follow the instructions given in the answer above referred to. 4. When I put the paper in the frame, and expose it to the sun, it turns brown instead of blue. Is this as it should be? *A.*—The color of the paper when exposed to the sun will turn a dark grey color, and will turn blue when put into the water. If you follow the instructions carefully, you will be successful.

(54) C. E. Q., Tilton, N. H., asks: Can you tell me how small escutcheon pins, screws and other small iron and steel articles are "blued"? We wish to blue small pieces of steel about ¼″x⅝″x 1-64″. We use large quantities of small screws, pins, etc., about 3-16 of an inch long, and as they come blued, we thought that these pieces might also be blued in quantities and evenly. *A.*—Such pieces can be blued in quantity and evenly by putting them into a vessel preferably made of sheet iron, and having an opening at the top somewhat smaller than the body of the vessel. A long iron handle is attached, and into the vessel the articles to be blued are placed, together with a quantity of fine clean sand. This is then held over a forge fire and constantly shaken, the handle being supported by a rest fixed upon the forge. By the constant shaking the heat is kept evenly distributed through the sand, and the articles can be brought to any desired color, its brilliancy depending upon the previous finish of the pieces. Sometimes, where very large quantities are to be blued, tumbling barrels driven by power are substituted for the hand ladle.

(55) E. H., Philadelphia, asks: How is the width of gear teeth proportioned to transmit 10 horse-power, number of teeth, diameter and number of revolutions being given? *A.*—Gears are not proportioned in that way, but when the power to be transmitted is known, the pitch and other dimensions are chosen in accordance. Beyond a certain limit, little or no additional strength is gained by increasing the width of face. For cast gears, the breadth is usually made equal to 2½ or 3 times the pitch, though in some cases it may be 4 times the pitch. Above this width there is practically no gain of strength, and usually there is comparatively little gain in making the breadth more than 2½ times the pitch. The reason for this is that a uniform bearing cannot be secured all along the teeth, and, when overloaded, the corners of the teeth are broken off; the strength of the corners being independent of the breadth of face. Cut gears may be somewhat wider, because better contact is secured by cutting, and by the greater care taken in the construction of machines using cut gears. The minimum breadth for cut gears is usually 3 times the circular pitch.

(56) W. G., Milwaukee, Wis., writes: We have a shaft with a load on it, which sometimes has to be revolved by hand. To do so, we apply the power to the fly-wheel which is on the same shaft. I would like to know which of the two following ways will require the least power to revolve the shaft? 1st. One end of the rope is fastened to the bottom of the fly-wheel at a point which lies in a vertical line through the center of the shaft; the rope is then passed one and one-quarter times around the fly-wheel, so as to bring the direction of the power which is applied at the other end of the rope in a vertical line. 2d. The rope is fastened to same point on the fly-wheel as before. But in this case the rope is passed around one-quarter of the circumference of the fly-wheel only, so as to bring the direction of the power in the same vertical line as before. The pull in both cases is, of course, upwards. *A.*—The power required to move the shaft in both cases is practically the same. The only difference between the two methods is that, by the first one, the shaft can be revolved one and one-quarter times; by the second it can be revolved one-quarter time only before the rope must be rearranged on the fly-wheel.

(57) G. S., Milan, Italy, writes: I am building a double well pump, plungers 2½ inches diameter, 9 inches stroke. The pump is arranged for stand pipes. Pump rods are made of copper; barrels, buckets, retaining valves and door are made of gun metal; cast-iron air chamber with 1-inch delivery pipe. All parts of the pump tested to a pressure of 300 pounds per square inch. One gun metal check valve fixed in the delivery pipe near the pump. Speed of pump, 12 revolutions per minute. The water level is subjected to a variation of 26 feet 3 inches between summer and winter. The enclosed sketch will show the construction of the pump. The pump is to deliver 200 gallons of pure water per hour, through a pipe 1,660 feet long with a total vertical height of 446 feet. I would like to know if you approve of the construction? Do you think it will be necessary to place one or more check valves in the delivery pipe? *A.*—Your construction is all right, with the exception of the manner of attaching the delivery pipe: this pipe should be attached at the bottom of the air chamber, and not at the top as you have shown it. You will not need any other check valves in the delivery pipe besides the one you have. It will also be advisable to attach to the boiler feed pipe an injector or a small pump for feeding the boiler.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Gear wheels and g-cutting. Grant, see adv., p. 16.

Link Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N. Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

The Improved Justice Hammer. Williams, White & Co., Moline, Ill., manufacturers.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

Berryman Feed Water Heater and Purifier. Benj. F. Kelley, 91 Liberty street, New York.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

"Swift" Sight Feed Lubricator; no glass tubes; simple, reliable. Swift Lub'r Co., Elmira, N. Y.

Power measured with guaranteed Dynamometers. Franklin Van Winkle, 91 Liberty st., New York.

R. Dudgeon, 24 Columbia st., New York. Improved Hydraulic Jacks and Roller Tube Expanders.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Common-sense oil filters are a wonder. They repay cost quickly. C. F. Baker, Minneapolis, Minn.

Ice and Refrigerating Machines, 131 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

"How to Keep Boilers Clean." A 96 page book mailed free by Jas. E. Hotchkiss, 120 Liberty st., N. Y.

Selden Packing, for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Brown & Sharpe Mfg. Co. have a line of machinery with S. A. Smith, 23 S. Canal st., Chicago, Ill.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.

Upright drills, improved, sizes 21″, 23″, 25″, 28″, 32″, 36″ swing; finely made and great capacity. Currier & Snyder, Worcester, Mass.

Patents obtained. Patent litigation conducted. R. G. DuBois, Patent Attorney, 928-930 "F" street, Washington, D. C. Correspondence invited.

Split Pulleys at low prices and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See Jan. 3, p. 15. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Fine tools and supplies for machinists and other metalworkers. Get our prices before purchasing elsewhere. Montgomery & Co., 105 Fulton st., N. Y. City.

See illustration of improvements in Hooks for Steam Engines, in Nov. 24 issue. For particulars address T. C. Dill Machine Co., 726 Girard av., Phila., Pa.

The Holly Manufacturing Company, of Lockport, N. Y., will send, on application, their pamphlet illustrating pumping machinery and reports of duty trials.

With my System, Exhaust Steam Heating costs nothing for fuel; Live Steam Apparatus altered to Exhaust. Satisfaction guaranteed. Geo. A. Barnard, 15 Cortlandt street, New York.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches, working drawings for the transmission of power by steam, water, air and electricity.

Contract work of all kinds executed promptly and on reasonable terms. Parties wishing grey iron castings in large quantities can make money by corresponding with Rawson Mfg. Co., Hornellsville, N. Y.

The Vance Lightning Flue Cutter is *the* tool for removing old flues from boilers and locomotives (will cut fifty an hour); sent on approval to railroad companies. Vance Tube Cutter Co., Geneva, N. Y.

A system of easy lettering, by J. H. Cromwell, giving 26 forms of alphabets. The space to be lettered being divided into squares; simple and effective. Price 50 cents. Catalogue of books for engineers free. E. & F. N. Spon, 12 Cortlandt st., N.Y.

Special facilities for the manufacturing of all kinds of light machinery, hardware and novelties, by contract or otherwise. Presswork and stamping done on short notice. Estimates furnished. Punches, dies and special tools made when required. Rockaway Mfg. Co., 3 E. 14th street, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

"Practical Drawing." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including Jan. 3, 1889 issue, 67 articles have been so far published. Copies containing these articles sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"Modern Locomotive Construction." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 82 articles have thus far appeared up to and including the Jan. 10, 1889 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

MANUFACTURES.

A paper mill will be built at Manchester, Conn., by F. D. Hale.

M. DeBurgh is building a machine shop 35x60 feet, at Roanoke, Va.

Dilworth, Porter & Co., Pittsburgh, Pa., are building a new spike mill.

The Georgia Pacific Railroad will build a car shop at Birmingham, Ala.

The Kentucky Central Railroad Co. will build new shops, probably at Lexington, Ky.

The Kennon Manufacturing Company will build a woolen mill, 60x360 feet, at Brunswick, Ga.

The W. T. Adams Machine Company are increasing the capacity of their shop at Corinth, Miss.

At the Lowell (Mass.) machine shop, the men are working till ten o'clock three nights in the week.

Bloomingdale Brothers will build a silk factory on West 85th street, New York, near the Boulevard.

The Pittsburgh (Pa.) Brass Company has filed a charter. The capital stock is $100,000, in shares of $50.

The Curry Manufacturing Co. has been organized, to manufacture agricultural implements at Florence, Ala.

The new mill of the Burden Iron Company, at Troy, N. Y., is 62x322 feet, and will have a capacity of 150,000 horseshoes per day.

A correspondent of the New Orleans *Times-Democrat* says there is great need of a rice cleaning mill and a canning factory at Opelousas, La.

Wm. F. Nevergold will at once commence the erection of a rolling mill at Rome, Ga., to manufacture hoop, cotton-tie and bar iron.

T. R. Almond, Brooklyn, N. Y., recently received orders from the ordnance department of the French Government for two of his couplings for coupling shafts at any angle.

John Wiley & Sons, 15 Astor place, New York, have issued a supplementary catalogue of industrial and scientific books published by them during the year 1888, which will be sent free on application.

Our Taunton (Mass.) correspondent was in error last week in writing that the Mason Machine Works were building narrow gauge engines for the Revere Beach Railroad. These engines are being built by the Taunton Locomotive Mfg. Co.

S. W. Card & Co., Mansfield, Mass., have issued their 1889 catalogue of taps, dies, screw plates, wrenches, etc. They make a variety of such tools, which are quite fully illustrated. The catalogue is clearly printed, on excellent paper, and the back is reinforced in a way that will preserve it for some time.

The Reliance Gauge Company, Cleveland, Ohio, have just received the fifth order from the Dick & Meyer Co., whose sugar refinery is located at Brooklyn, N. Y., for their Reliance Safety Water Columns. It calls for 15 of the No. 5 combined high and low water alarms. This refinery first tried these safeguards in October, 1886, and their endorsement in the form of repeated orders, after long-continued and constant use, must be gratifying to the manufacturers.

The St. Louis Electric Light and Power Company have purchased a valuable piece of ground on Twenty-first street and Lucas place (Locust street), and will erect thereon a large central lighting and power station. The Missouri Electric Light and Power Company also purpose to erect a central station, and for this purpose have purchased 170 feet front on the southeast corner of Twentieth and Lucas place (Locust street). They will put in a 4,000 horse-power steam plant at that location, it is rumored, but this estimate is probably too large. The company are also arranging for extensive wiring throughout the city.—*Age of Steel.*

The *Springfield* (Mass.) *Republican* says: A new industry will be started in this city about the first of next month, in the old silk mill of the Springfield Silk Mills Company, at the junction of Mill and Maple streets. The new establishment will go under the firm name of E. P. Booth & Co., and will be called the Mill River Silk Works. The industry will consist in the manufacture of silk braids, machine twists and sewing silks, and the company will also "do the throwing" of organzine tram. A well-equipped dye-house will be open to a general business with the public. The works will start with a force of about 50 girls, which will be increased to about 75 when the business is well fixed.

The New Castle (Pa.) *Guardian* says: A series of experiments were tried at the Etna Iron Works, this city, Monday, in the manufacture of steel spikes. The object is to make a finished article by rolling the bar so that its width will be the length of a spike, and in such a shape that the spikes may be cut from it with shears, pretty much as a cut nail is made, except that the head is formed in the rolling process. The rolls were turned by Charles and James Mathews, of this city, and were set and operated under the direction of Mr. R. Garvin and Superintendent T. M. Sweeney. At noon the first test was made by running through some steel rails that had been slowly heated for two and a half hours. The result was fairly successful, and it is thought that a few changes in the rolls will make the operation entirely satisfactory. Should the scheme be successful, it will work a revolution in the cost and manner of making railroad spikes.

Machinists' Supplies and Iron.

NEW YORK, Feb. 2, 1889.

Iron—American Pig.—Transactions are still confined to the current requirements of consumers. There is a feeling of uncertainty, which prevents large transactions, and consumers are disposed to hold off, in anticipation of a revision of prices and a steadier market. No changes have been made in current quotations, though some iron is being sold for future delivery at prices then current.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—See bottom of third column, page 11.

Wanted—By a practical machinery pattern maker, position as foreman. Box 819, Hartford, Conn.

A mech. draftsman with exp. wants position; New York or vicinity preferred. P. T., AM. MACHINIST.

Wanted—By a practical iron moulder, position as foreman; over 15 years' experience; references. G. E., 2 West Leigh st., Richmond, Va.

Wanted—metal spinner. A good competent man on plain work; state experience, and wages expected. Address "Ohio," AMERICAN MACHINIST.

Wanted—Experienced draftsman, familiar with requirements of pattern and foundry work; ref. required. State particulars. Box 3148, Boston, Mass.

Good mech. draftsman, graduate, some experience, wants position on engine and boiler work. Address Box 65, AMERICAN MACHINIST.

Wanted—Position as general manager or foreman of boiler shop; employed at present as foreman; first class references. Foreman, AMERICAN MACHINIST.

Wanted—By practical pattern maker and draftsman, position as foreman pattern maker. S. K., AMERICAN MACHINIST.

To Blacksmiths. Wanted—A locomotive frame maker to work by piece; steady employment. Correspondence invited. Blacksmith, AM. MACHINIST.

Wanted—A Mech. Draftsman with some tech. education and exp. in High Speed Engine Design. Permanent position to right man. Address, stating experience, and salary desired, "Gregor," AM. MACH.

Wanted—To make arrangements with a good house to travel with steam goods and special supplies; have had 14 years' experience; East or West; best of references. Address M., AM. MACHINIST.

Situation wanted by a designer of tools and automatic machinery; also a practical mechanic, or as manager with some enterprising manufacturing concern. Address C. P. B., AMERICAN MACHINIST.

Wanted—Position as foreman of machine shop; good manager; long practical experience on standard and special machinery, tools, fixtures, etc.; best references. Address M. D. C., AMERICAN MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 15 cents per line, each insertion.

The Cyclone Steam Flue Cleaner is king; and has no rival. Crescent Mfg. Co., Cleveland, Ohio.

Crescent grease cup for shafting beats them all. Sample free. Crescent Mfg. Co., Cleveland, Ohio.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

August C. Christensen, 24 State St., N. Y., consulting engineer for hydr. and pumping machinery, etc.

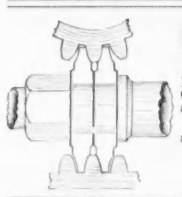
Punches, Dies and special machinery built to order. C. F. Langston & Co., 70 N. 4th St., Phila., Pa.

The patent on scale for measuring pipe and fittings, as shown in AMERICAN MACHINIST, Jan. 24, is for sale. W. L. Cheney, Hartford, Conn.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

Wanted—To buy second-hand lathes, planers and shapers of all sizes; must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

The owners of Patents for the manufacture of improved Cast-iron Pulleys by a method that reduces the cost 40% below present processes, propose to license a few parties to manufacture. Correspondence solicited. Address "Pulley," AM. MACHINIST.



CLOUGH'S PATENT DUPLEX CUTTER

For cutting the teeth of gears; one Cutter cuts a pitch from 18 teeth to a rack inclusive.

Send for descriptive circular and price list.

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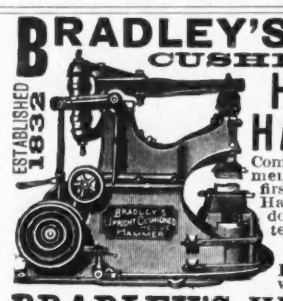

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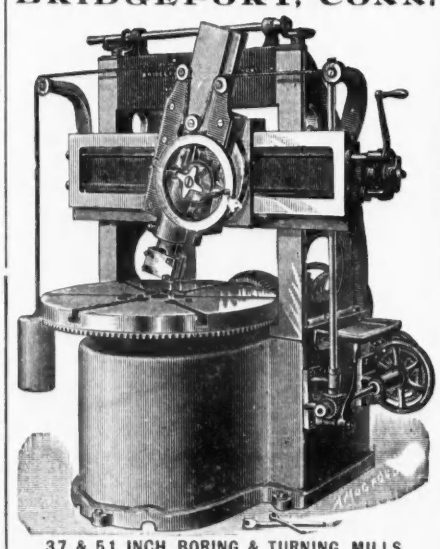

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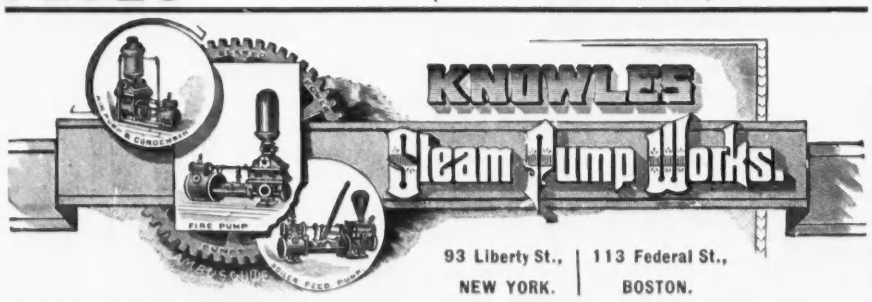

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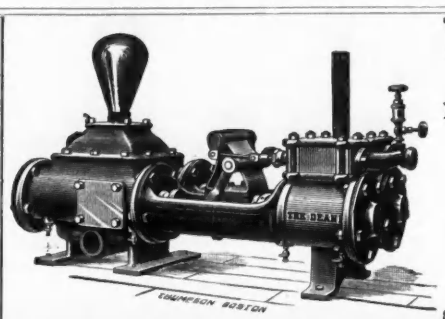

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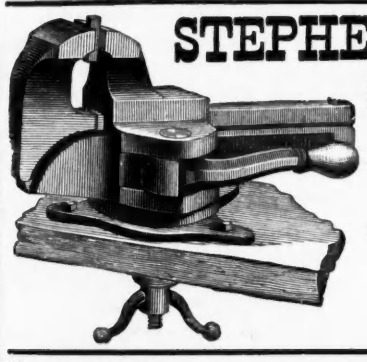

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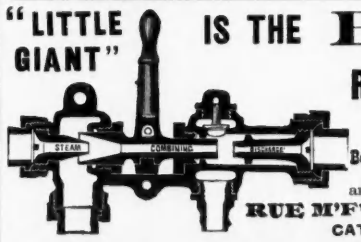

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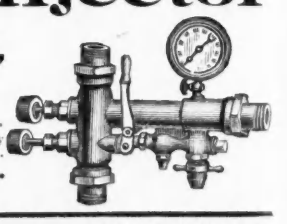

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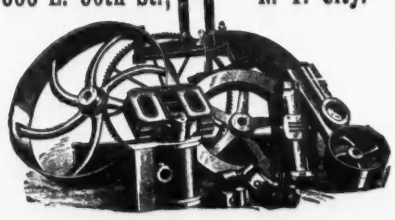

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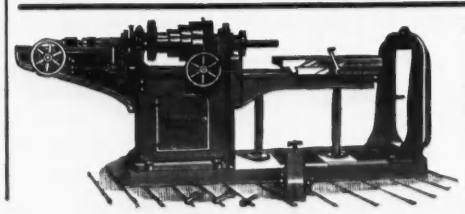

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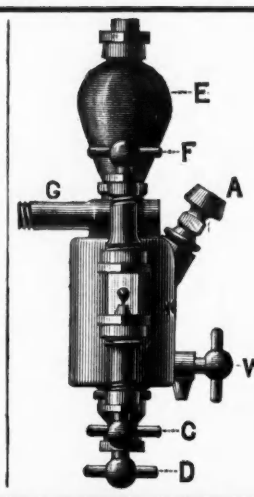

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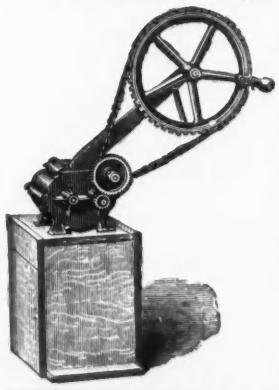

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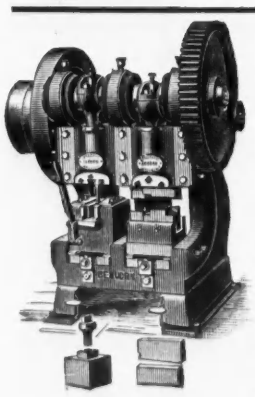

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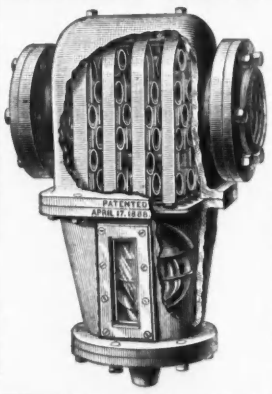

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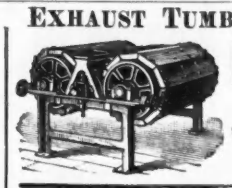

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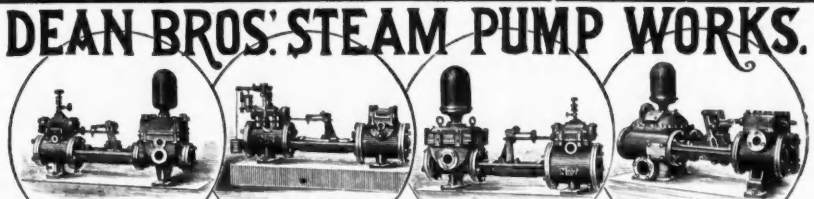

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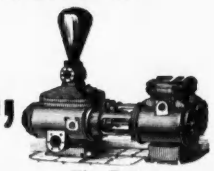
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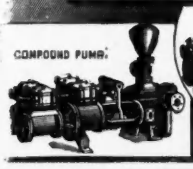
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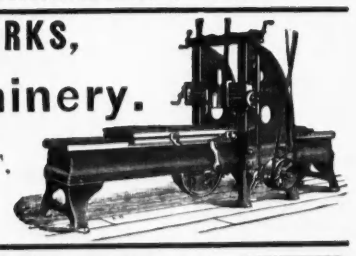

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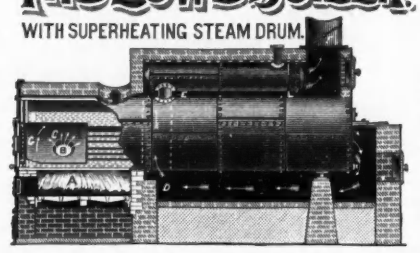

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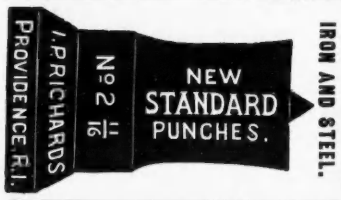

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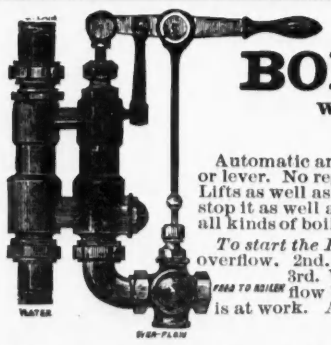

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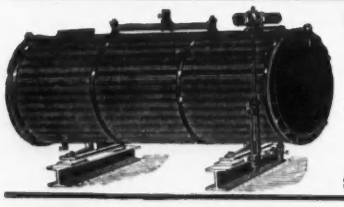

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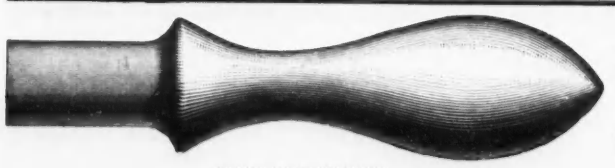

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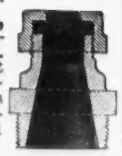

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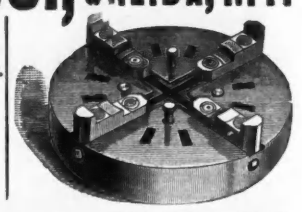

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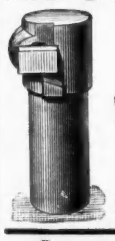

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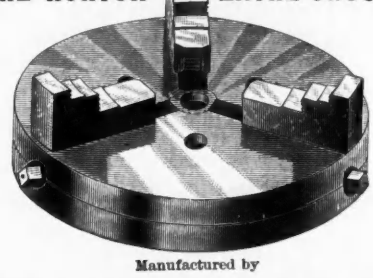

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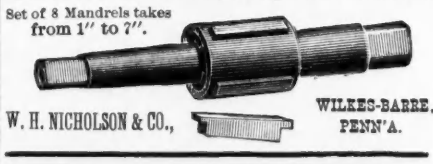

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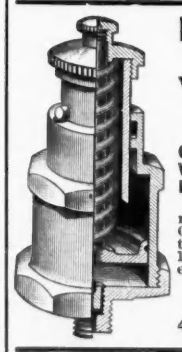

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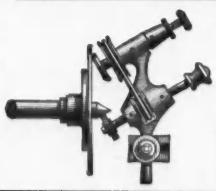

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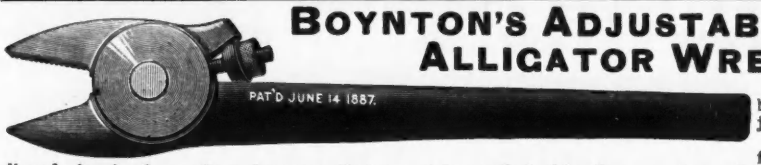

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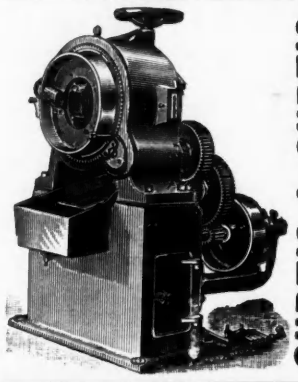

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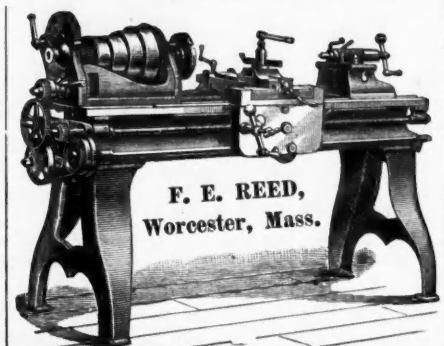

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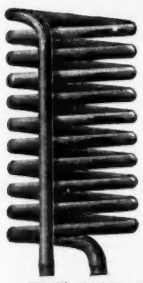

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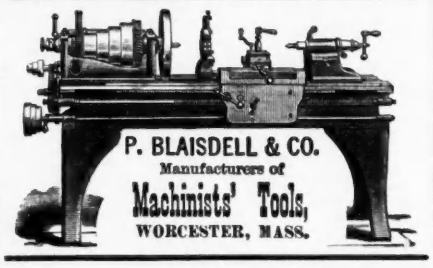

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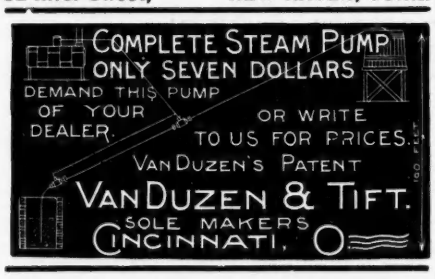

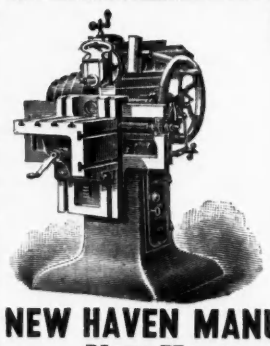

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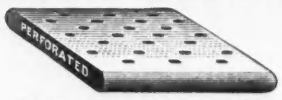

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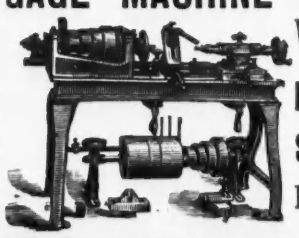

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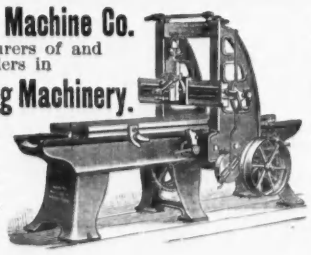

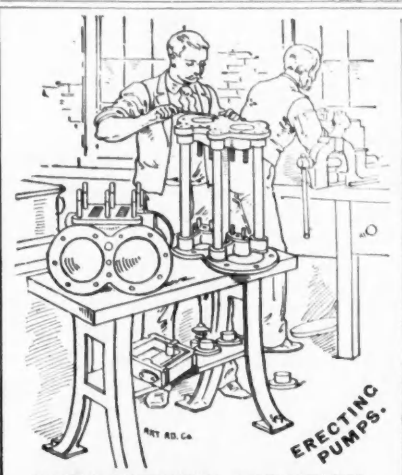

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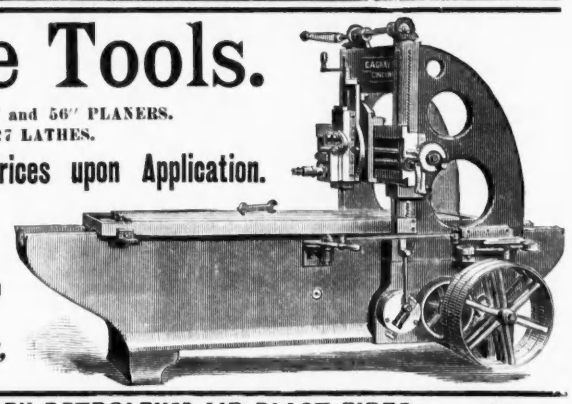

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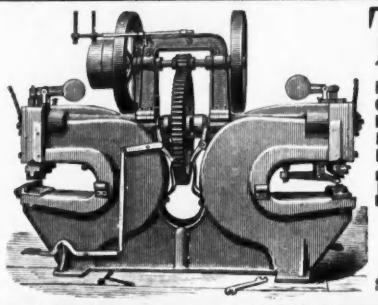

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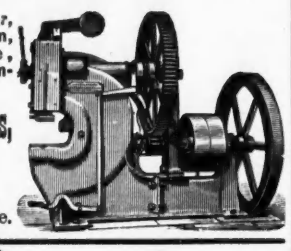

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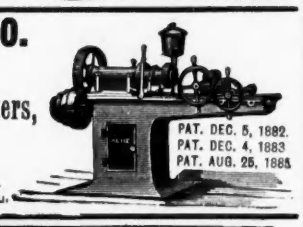

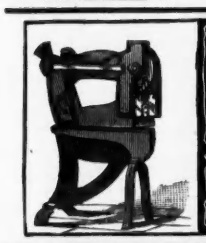

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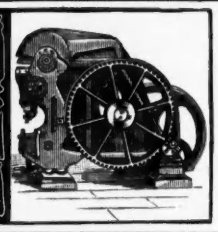

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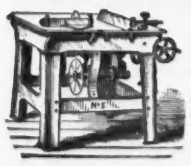

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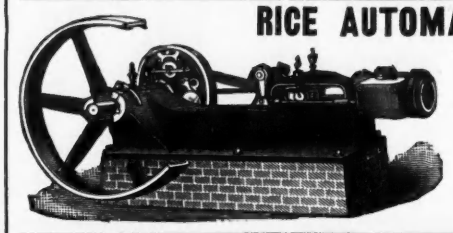

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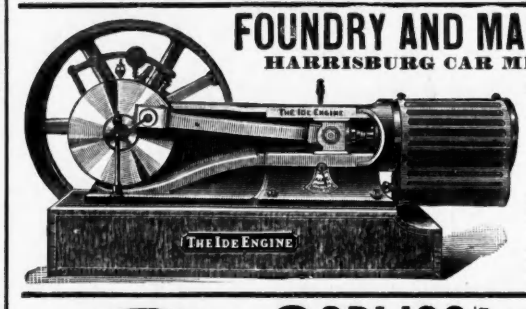

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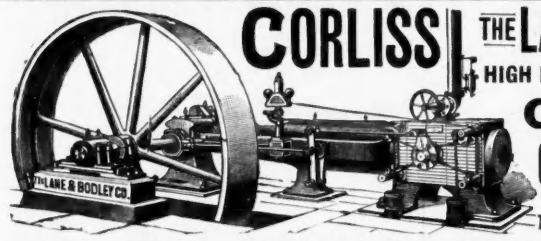

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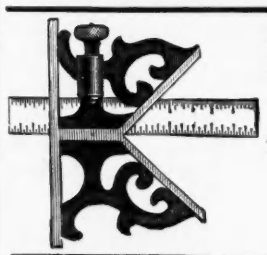

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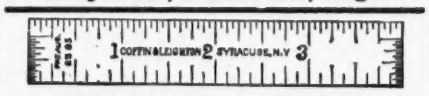

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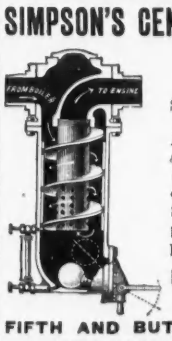

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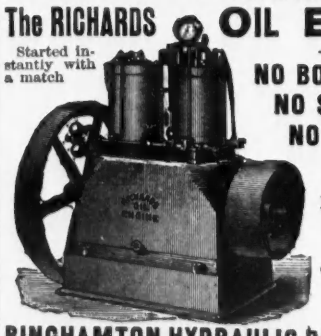

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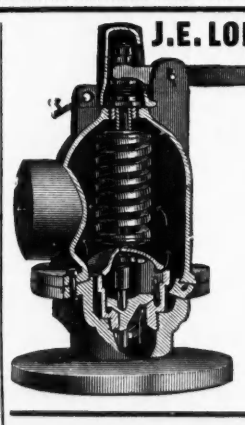

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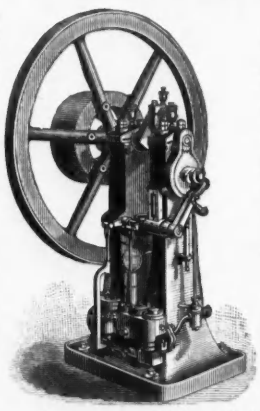

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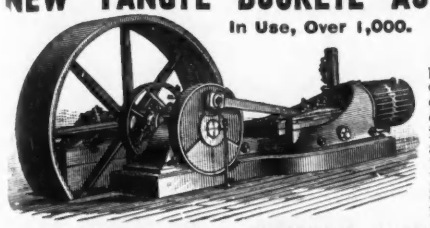

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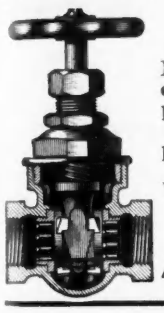

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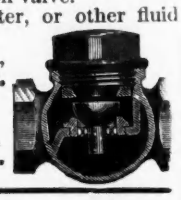

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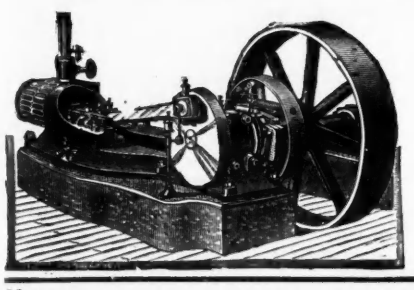

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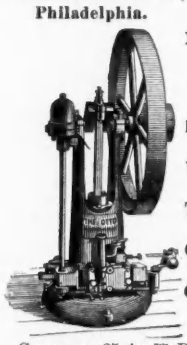

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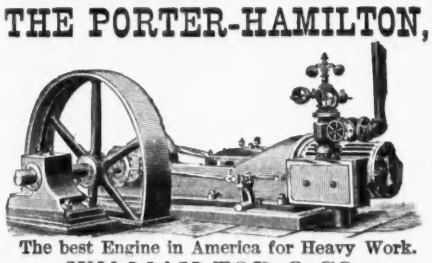

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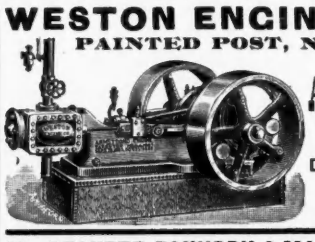

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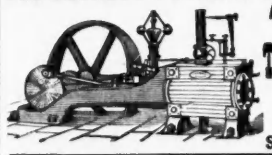

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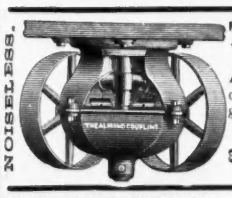

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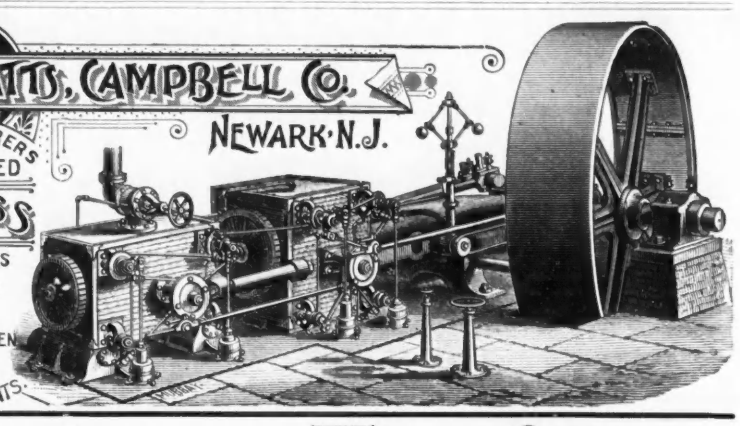

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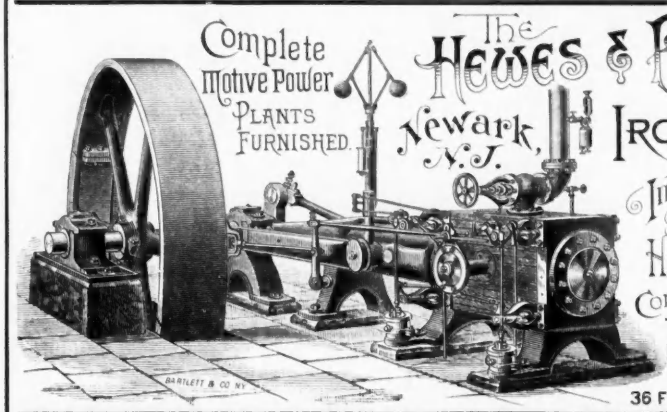

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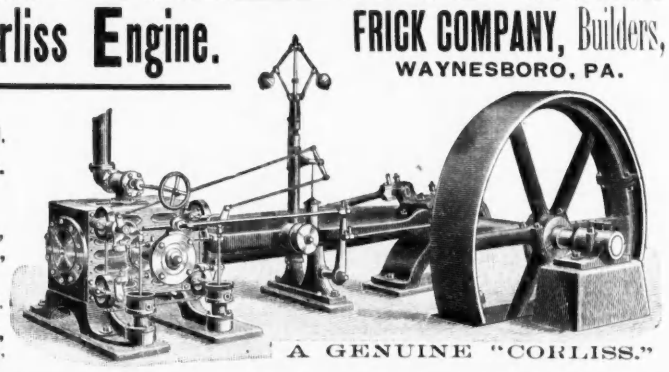

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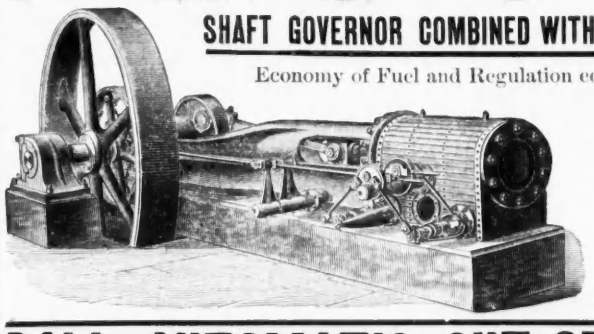

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NEW YORK SELLING OFFICE, 15 CORTLANDT STREET.

STEARNS M'F'G CO.

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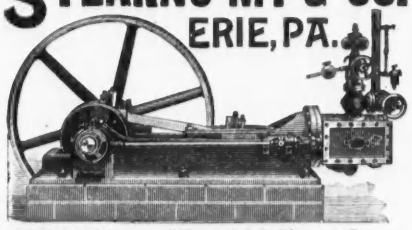

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Boilers of Steel and Iron supplied to the trade or the user. Send for Catalogue.

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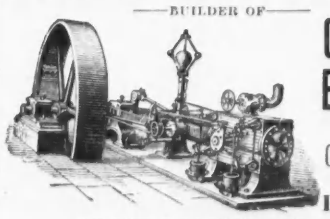

CORLISS Engines, AIR Compressors and BOILERS.

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TAKEN IN TRADE FOR NEW.

10" x 5' Engine Lathe,	F. E. Reed.
12" x 5' Engine Lathe,	Prentice, (new).
15" x 6' Engine Lathe,	Lathe & Morse.
16" x 6' Engine Lathe,	Powell.
16" x 6' Engine Lathe,	Blaisdell.
16" x 11' Engine Lathe,	New Haven.
20" x 8' Engine Lathe,	Powell.
21" x 10' Engine Lathe,	Lathe & Morse, (new).
26" x 10' Engine Lathe,	Putnam Machine Co.
Cabinet Turret Lathe,	Lodge, Davis & Co. (new).
16' x 16" x 3' Planer,	Lathe & Morse.
24" x 24" x 6' Planer,	Chamberlin.
30" x 36" x 6' Planer,	Hendey.
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36' x 36" x 10' Planer,	Whitcomb, (new).
42" x 42" x 10' Planer,	William Gleason.
15" Stroke Shaper,	Hendey.
20" Upright Drill,	Prentice.
22" Upright Drill,	Reed.

Above 2d-hand tools are in first-class condition. Write for list giving prices and descriptions.

We also carry much the largest stock of New Machine Tools in the country.

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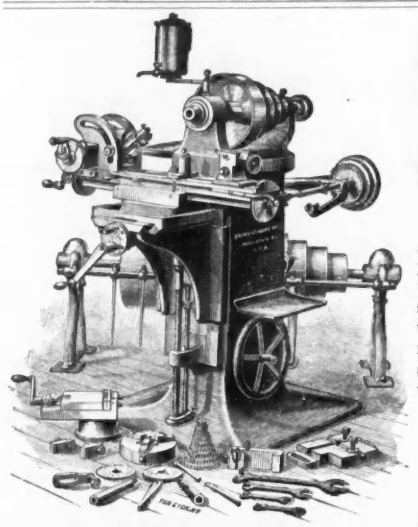

No. 1 Universal Milling Machine.
Made with and without overhanging arm.

THE ORIGINAL
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Made by the
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Are kept in stock and sold at favorable prices, compared with any of their *IMITATIONS.* By making these Machines in large numbers, with expensive special tools much greater accuracy has been attained than can be reached by the usual methods of manufacture. The importance of the greatest attainable accuracy in *TOOL-MAKING MACHINES* will be appreciated by Machinists.

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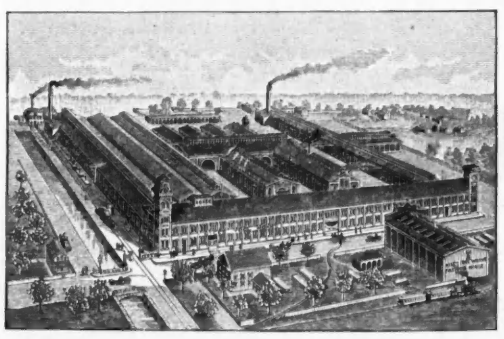

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OF EVERY VARIETY.

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CRANES THE YALE & TOWNE MFG CO.
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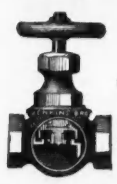

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Owing to the popularity the JENKINS BROS. VALVES have attained, the market has been subjected to BASE IMITATIONS.

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Jenkins Bros. are Warranted Full Opening.

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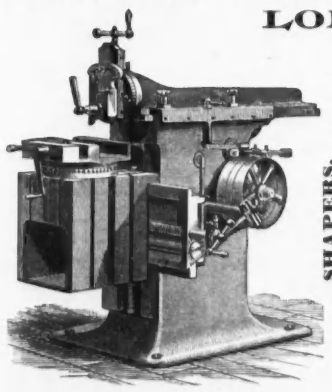
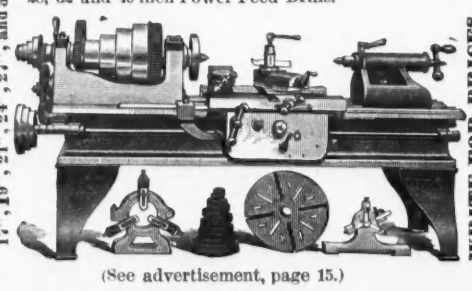
SHAPERS, ENGINE LATHES AND DRILLS.
LODGE, DAVIS & CO.,
CINCINNATI, OHIO.



SHAPERS, 15" and 20" Crank, 20", 26", 32" Geared.
ENGINE LATHES, 17", 19", 21", 24", 27", and 38".

20 inch Upright Drills. 25 inch Back Geared,
24 " " " and
28, 32 and 40 inch Power Feed Drills.



WRITE FOR PRICES, IT WILL PAY YOU.

(See advertisement, page 15.)

GOULD & EBERHARDT,
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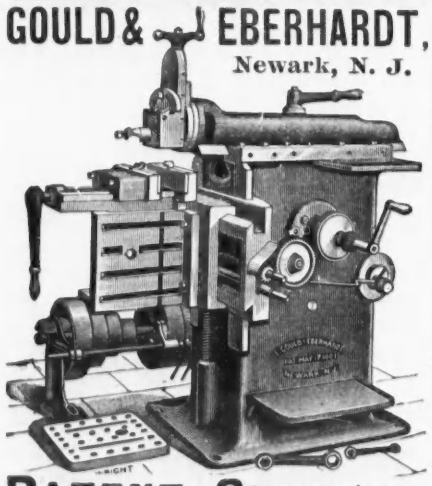

PATENT SHAPERS.
Sizes, 10", 15", 20", 25" and 30" in stock.
GEAR AND RACK CUTTING TO ORDER.

HEADQUARTERS IN NEW YORK CITY FOR
STANDARD
Milling Machines,
UNIVERSAL OR PLAIN FOR LIGHT HEAVY WORK.
All sizes ready for quick delivery.
Machines shown in operation by the man'f'rs,
E. E. GARVIN & CO.,
139-141-143 CENTRE STREET,
Send for Illustrated Catalogue. NEW YORK CITY.

THE PRATT & WHITNEY CO.
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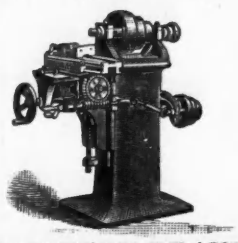

Manufacture Plain Milling Machines, with hand and power feed, of several sizes. Index, double face, vertical face, double spindle and shuttle race Milling Machines. Cam Cutters and Profiling Machines of several kinds. Milling Machines, Vises and Centers. Milling Cutter and Twist Drill Grinding Machines.
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MANUFACTURERS OF
STANDARD MACHINE WRENCHES
DROP FORGED OF
BAR STEEL
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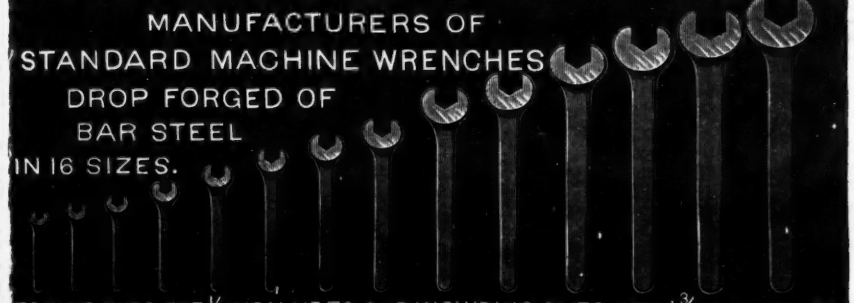

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MACHINE TOOLS
For Iron and Brass Work.
SMALL TOOLS & FIXTURES.
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ILLUSTRATED CATALOGUE ON APPLICATION.

GEO. W. FIFIELD,
MANUFACTURER OF
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FROM 16 to 48 IN. SWING.
Cuts, Photographs and Prices furnished on application.
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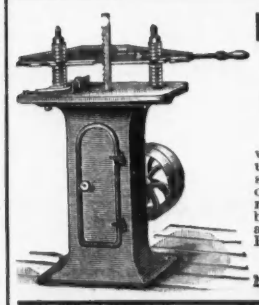
Gear Wheels and Gear Cutting.—I make g to order, or cut teeth on g blanks sent to me. Of all kinds. Of all sizes to six ft. dm. Small orders or large ones. Fine g or cheap g. Small cast g. Ready made brass g by mail at low prices. Bevel g with perfect planed teeth. Hand Book on g, $1. Facilities complete. Terms reasonable. Send for cat. GEO. B. GRANT, 66 Beverly St., Boston, Mass.



KEY-SEATING MACHINES,
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A SPECIALTY.
Our Key-Seating Machine will save enough in 60 days' use to pay first cost; no shop can afford to do without one. We have now ready for prompt shipment both Key-Seating Machines and 20-in. Drills. Send for Photo. and Catalogue.
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NORTH BLOOMFIELD, N.Y.

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Formerly of Worcester, Mass.

The new shops of this company are located at Plainfield, N. J., forty minutes' ride from New York city on the line of the Central Railroad of N. J., and consist of the following:

A machine shop 500' long by 100' wide; a foundry 250' long by 90' wide; also commodious buildings for the storage of sand, coal, coke and pig iron; ample and convenient wash rooms for the men; fireproof two story pattern storage; blacksmith shop; engine and boiler houses. These buildings are detached from the machine shop and foundry. There is an elevated railroad for the convenient distribution of raw materials, and a railroad running through the machine shop for shipping. The whole plant is supplied with the incandescent system of electric lighting.

The machine shop and foundry have overhead traveling cranes running through their entire lengths; also light traveling cranes, which serve every tool, and a number of jib cranes in the foundry and scratch rooms. The foundry has capacity for making the heaviest class of castings.

All our tools are expressly designed for the economical manufacture of heavy machinery for railroad and general machine shop equipment, from new patterns of the latest and best designs.

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NEW SHOPS, Plainfield, N. J.

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
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PATENT UNIVERSAL SCREW-CUTTING CENTER DEPTH ANGLE AND
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Fine Machinists' Tools.—E. Boston, Mass—Send for Circular

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THE G. A. GRAY CO.,
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PRATT & LETCHWORTH,
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BUFFALO STEEL FOUNDRY,
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The STILES PATENT DROP HAMMER,
Manufactured by
THE STILES & PARKER PRESS CO.,
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ALSO MAKERS OF
PUNCHING STAMPING DRAWING **PRESSES** and DIES.
Branch Office and Factory, 203, 205 & 207 CENTRE ST.,
200 p. Catalogue on application. NEW YORK CITY.

J. M. CARPENTER
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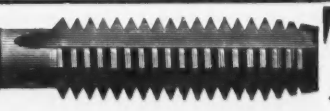

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